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AGRICULTURAL ENGINEERING

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Agricultural Engineers Look Beyond

By R. W. Trullinger[1]
President American Society of Agricultural Engineers

THROUGH the tireless efforts of agricultural engineers in public service and with commercial manufacturers of materials and equipment, economy and efficiency have been introduced into agricultural production practices to an eminently worth-while degree. As a result, the past quarter century has seen the wealth produced per agricultural worker in this country increase many fold, until at the present time a population of approximately 120,000,000 people is fed by barely 25 per cent of its number.

Increased efficiency in agricultural production practices has been accompanied also by better quality crops, improved dairy and poultry products, and better meats and other animal products. The introduction of electricity into these practices as a source of primary energy, and the development along more efficient lines of the use of animal and internal-combustion engine power, and of concentrated energy in the form of explosives, have had a tremendous influence in lightening the farm burden and in producing farm commodities of superior quality at lower costs.

Thus agricultural engineering has established its place and demonstrated its worth in the agricultural program during the past quarter century. It has supplied mechanical and structural means to secure higher quality farm products by less labor and at lower costs. Its greatest achievement has been to lay the foundations of a civilization which no longer recognizes or tolerates the agricultural burdens and drudgery of preceding generations.

However, the work of agricultural engineers has just begun. There are nearly six and one-half million farms in the United States. Of these, practically 88 per cent are of small or medium size, ranging from 3 to 260 acres. By virtue of their majority these small and medium-sized farms call for primary consideration in the refinement and economical adaptation of efficient methods and equipment for production at lower cost. If prosperity is to be widespread, the benefits of a civilization which prohibits drudgery and works toward industrial efficiency and independence must be extended also to the farmers on small and medium-sized farms; farmers who make these farms their homes as well as their means of livelihood, and who form the backbone of the population and business prosperity of the rural areas they inhabit.

In this connection, the development and refinement of agricultural methods and equipment are far from complete. The primary power used on farms still costs American agriculture approximately four billion dollars each year. Farm building construction requires nearly seven million dollars annually for maintenance. Losses from soil erosion total 200 million dollars annually. These costs are too high and indicate some of the problems which challenge the ability of agricultural engineers today, problems which must be solved. There are many others and their number is increasing as progress is made.

Thus, while the American Society of Agricultural Engineers can look with pride on the past years of its service to agriculture, it should be concerned now with the infinitely more vast possibilities for growth and achievement in future years. Those years are likely to present to agricultural engineers challenges of unprecedented magnitude which will become more numerous, specific and exacting with time, and which must be met in all quarters with engineering accomplishments of equal or greater magnitude.

[1]Senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture. Mem. ASAE.

The agricultural engineering building at the University of Wisconsin, where the American Society of Agricultural Engineers was founded in 1907

Launching a New Engineering Society

By J. Brownlee Davidson[1]

THE year 1907 came during a period of prolonged economic prosperity. The severe economic depression of 1894-95 was over a decade past. There were incredible rumors of wireless telegraphy, and motion pictures were being demonstrated as a novelty. The Wright brothers had conducted some experiments, foolish in the opinion of the general public, with flying machines. The automobile, while so rare that many states had passed laws to protect horsemen against the nuisance, was in process of development. Mud roads prevailed throughout the agricultural sections and railway travel was the only method to be considered for anything but short distances.

The horse had little competition as a farm motor. Steam tractors were in common use to operate threshing machines, and the gas tractor was looked upon as an impudent intruder. The historic Winnipeg Motor Competition had not been organized. The International Harvester Company, the first great merger of the farm machine manufacturers, had been organized but a few years.

Agriculture was becoming more and more prosperous, and the agricultural colleges were beginning to receive from the farmers some of the recognition which they coveted. Special trains to carry agricultural propaganda to the farmers were popular, in spite of the fact that the instruction was not always scientifically sound. Support to state agricultural colleges was increasing, the enrollment of students growing and new departments of instruction were being rapidly added. Departments of farm mechanics had been established in several of the state colleges. It was in such times as these that the American Society of Agricultural Engineers was organized.

With the expansion of agricultural education in the colleges it was recognized by agricultural educators, particularly in those states where mechanical equipment, buildings, and land reclamation were prominent, that engineering had a definite contribution to make to agriculture, but just how or by whom was not decided. In most institutions there was intense rivalry between the agricultural and engineering colleges resulting in a lack of cooperation which made it difficult to care for any common activity. Engineering educators often wanted to supply the demand for instruction in the engineering of agriculture without disturbing the set-up of the then existing professional branches. Agricultural educators wanted something special; they were quite sure what, but nothing "high brow." Instruction had to be practical, and the instructors considered best were grease-it-and-fix-it-men. Manufacturers were keen to cooperate in any project relating to sales, but were evasive and exclusive as far as engineering relationships were concerned.

It was in such a situation of conflicting views that the young engineers attempting to develop the engineering related to agriculture found themselves. To be sure there were agricultural and engineering leaders who had a vision of the service engineering could contribute to agriculture, and were willing to grant that there might be a field for the professional agricultural engineer, but ideas had not crystallized and it was easier to criticize than to assist with the development of the new branch of the engineering profession.

During this formative period, information for instruction was sorely lacking, and teaching technique was wholly undeveloped. Under such conditions cooperation thrives. During the fall of 1906 a small conference was held at the University of Illinois attended by F. R. Crane of that institution; C. A. Ocock, of the University of Wisconsin, and J. B. Davidson of Iowa State College. Others were invited but did not find it possible to attend. At this conference methods were compared and discussed in such a profitable way that it was agreed to make such a conference annual.

Those who attended the first conference formed or appointed themselves a committee to call a meeting of all instructors that could be interested and proceeded to arrange a program. The meeting was held at the University of Wisconsin, December 27 and 28, 1907. The number registering was about sixteen, most of whom are shown in the accompanying group picture. It was a surprise to some that so many could be interested in coming to such a meeting. One gratifying development was the interest of the technical press and commercial engineers; two electrical engineers attended the meeting and took an active part. A review of the papers indicated how completely each member in attendance was engrossed in his own problems. The great benefit and profit which came from this first meeting, like others where men with a common interest gather, was in the growth of enthusiasm for the work. Those present came feeling that they had a worth while job, but when they left the meeting they were inspired crusaders with a mission.

It was duly intended at the first meeting that some form of permanent organization should be formed, but there was a division of opinion as to just what the objec-

[1] Professor of agricultural engineering, Iowa State College. Charter Mem. A.S.A.E.

This picture was taken at the organization meeting of the American Society of Agricultural Engineers, at Madison, Wisconsin, December 27 and 28, 1907. Front row (left to right) —J. W. Criswell, J. B. Parker, F. R. Crane, J. B. Davidson, P. S. Rose, H. M. Bainer. Second row—W. M. Nye, C. A. Ocock, H. W. Riley, John Evans, E. A. White, M. L. King. Standing, rear—E. W. Hamilton, Walter Block. Present at the organization meeting but not in the picture—B. B. Clarke, L. W. Chase, John Wynn

tives of the society should be or who should comprise the membership. There were some who thought that, for the present, it would be better to modestly organize an association of instructors and thus perhaps avoid the criticism of the professional engineers. There were others, however, who thought the organization should represent a definite branch of the engineering profession with the avowed purpose of interesting all engineers concerned with the industry of agriculture. The late B. B. Clarke, editor of "The American Thresherman," after listening to the discussion, made one of the tempestuous speeches he was accustomed to deliver to threshermen's conventions, urging that agricultural engineering was a high calling and that those present should live up to their opportunity. "B. B." won the group, and it was voted that it should be a "society of engineers". Mr. Clarke, in my opinion, rendered a great service to the Society and his prophetic views have been fully proven by later developments.

After settling the question of the nature of the society, the name became a question for debate. Most of the colleges had departments of or instruction in farm mechanics, and agricultural engineering as such was not generally recognized. The late Dr. F. H. King, who was an interested listener to the discussion, made a plea for the use of the term "agricultural" to indicate the branch of engineering to be recognized. Dr. King argued that "agricultural" indicated clearly the engineering related to the industry, while other terms under consideration did not define the scope of the organization. His speech won the point, and upon motion it was voted to name the new organization the "American Society of Agricultural Engineers." To relate what happened following the first meeting would exceed my commission. The papers read at the initial meeting and the discussion related thereto are a matter of record in the A.S.A.E. Transactions. A constitution was drafted and adopted. Officers were elected, committees appointed, and the American Society of Agricultural Engineers was an established organization.

The records do not indicate, however, all that happened at the first meeting. B. B. Clarke and "The American Thresherman" were hosts to the new organization at a banquet, and those who believe it difficult to celebrate great events without the cup that cheers will be glad to learn that it was present at the initiation banquet of the Society. The first meeting was the beginning of lasting and valuable friendships, and to those who participated, the organization of the American Society of Agricultural Engineers has been one of life's prime events.

Engineering's Service to Agriculture

By Philip S. Rose[1]

AT THE beginning of the last century almost every farm operation was performed by hand. Today, there are very few farming operations that are not or can not be performed by mechanical power. The men who devised the machines and the methods which have transformed farming from hand labor to machine labor, were agricultural engineers.

Unfortunately, previous to the formation of the American Society of Agricultural Engineers these men enjoyed no special designation. They had no professional standing. There was no place where they might file a record of their achievements, no place where they could meet and discuss their professional problems.

Here were real needs to be supplied and the American Society of Agricultural Engineers was organized to provide them. The men who were attempting to teach various phases of what is now known as agricultural engineering, took the initiative because they felt the greatest need of professional standing. They needed an agricultural engineering literature, and they needed a forum in which they might discuss their particular problems.

Originally the membership of the Society was composed almost wholly of college teachers. They were naturally concerned first with definitions which would enable them to lay out courses of study. These activities sufficed for a time, but once the field was mapped out something else was needed to maintain interest.

There was clamor from the members that the Society do something, that it undertake standardization, research, something big and spectacular that would command attention.

What was needed, of course, though not every one was able to see the need at first, was the vitalizing influence of commercial engineers bringing their problems and the results of their researches to the Society for general discussion.

At first commercial engineers and the companies they represented were slow to see the advantages to them of the new Society. But the sudden rise of interest in the tractor and other power machinery due largely to the World War, followed by the extension of electric power lines to the farms made the need of an agricultural engineering society evident to everyone.

Even the older professors of agriculture came to realize that modern agriculture is as much engineering as it is crops, livestock or bacteriology. Today, the agricultural engineer is recognized as a full equal in all agricultural college faculties. He is also recognized as a technical equal by the engineers in the other great branches of engineering.

Now what have agricultural engineers accomplished to deserve their present status of popularity? For a young society the record is impressive.

1. The American Society of Agricultural Engineers has grown to have a satisfactory membership which includes not only all the teachers of agricultural engineering in the various colleges, but nearly all of the commercial engineers who delve into agricultural subjects.

2. The Society has acquired a fairly large and rapidly growing literature. Its Transactions represent the largest fund of knowledge on the various aspects of agricultural engineering in the world.

3. The Society has given its members a professional standing that is a valuable consideration to every one entitled to wear the emblem. This is a first essential to maintaining an agricultural engineering personnel.

4. It has made agricultural engineering a co-equal with other branches of engineering, so recognized by the other national engineering societies.

5. It has exercised a powerful influence in mechanizing all phases of rural life including the home as well as the barn, outbuildings and fields.

6. The American Society of Agricultural Engineers is largely responsible for the progress rural electrification has made thus far, and it helped set the machinery in motion for the vast amount of rural electrification that is certain to come within the next few years.

7. The American Society of Agricultural Engineers has introduced engineering methods into all farm operations and has profoundly affected all previous conceptions of farm management.

Every member of the American Society of Agricultural Engineers may well feel proud of the quarter century of achievements. I can testify that what it has accomplished exceeds the most sanguine hopes of the small group of charter members.

[1]Editor, "The Country Gentleman," Charter A.S.A.E.

Agricultural Engineering Takes Its Place

By O. V. P. Stout[1]

A SUB-COLLEGIATE school of agriculture was established in the University of Nebraska about 1895. In a catalogue of the University, published in June, 1896, it appears that the school faculty included "O. V. P. Stout—Agricultural Engineering" and "C. R. Richards—Practical Mechanics."

Be it legend, or be it historical fact, I have been credited as the first to advocate agricultural engineering at Nebraska. The initial inspiration came from my contact with irrigation—where, even in that day, the engineer had to be somewhat of a farmer and the farmer somewhat of an engineer—and from association with Elwood Mead who, along with his many other distinctions, enjoys that of having been, at Colorado Agricultural College in the early eighties, the first teacher of irrigation engineering in this country.

I was not an especially vociferous advocate, but I did some talking and some writing, some of it in reports as head of the civil engineering department, to the University government. The time must have been ripe, for it went over rather easily. One day I was appointed to sit on a committee to frame courses for the school of agriculture and was given to understand that there would be a place for some agricultural engineering. Hence, the catalogue announcement in 1896. Subjects listed under agricultural engineering were: Farm survey with chain, drainage leveling, topographical survey for irrigation or landscape gardening, measurement and division of water, application to crops, and minor irrigation structures. Under the head of agricultural mechanics were draft of vehicles and implements, wind wheels and pumps, strength of timber, ventilation of buildings, bearing power of soils, and elementary study of heat. Practical mechanics included carpentry and blacksmithing. The catalogues for the next succeeding years show no change in titles and content of courses. In the catalogue published in July, 1899, Richards was listed as professor of practical mechanics and I as professor of agricultural engineering.

In the catalogue published August, 1900, a three-year curriculum in the school of agriculture is set forth, with corresponding increase in time given to engineering subjects, while titles and descriptions of courses remained unchanged.

The term agricultural engineering does not appear in the catalogue of July, 1902. I was no longer connected with the school of agriculture. The work in practical mechanics, under the direction of Richards, continued, and was rewarded in 1903 with the construction of an $11,000 building "for instruction in carpenter work and blacksmith work and the study of farm machinery." The farm machinery part of it proved an attraction for collegiate students in both agriculture and engineering, and gave a material impetus to the work. Implements and machines were freely loaned by manufacturers and dealers, and a representative assortment was soon on hand.

Before this building became available on the farm campus the work in practical mechanics was done in the shops on the city campus, nearly three miles distant. The present agricultural engineering building was built about a dozen years later. At the time of its completion there were not more than one or two others anywhere to compare with it.

The name of Jay Brownlee Davidson, instructor in forge work and farm machinery, appears in the catalogue published in July, 1904. His position and his activities were more than the title indicates, and his accomplishment was such by the end of the year that he was called to Iowa State College. His classmate, Leon W. Chase, succeeded him, and carried on to such effect that by July, 1908, we find him in charge of a separate department of farm mechanics, with the title of associate professor, and offering work "primarily for undergraduates in engineering, and in the general and technical agricultural groups." The department staff listed in 1909 consisted of Professor Chase, C. K. Shedd, A. A. Baer and O. W. Sjogren.

In the meantime, renewed attention had been given to the civil engineering phases of agricultural engineering, so that in the catalogue of May, 1910, the statement of the department, now become the department of agricultural engineering, takes account of the subjects under that head. A four-year curriculum appears, the students registering in the college of engineering. This seems to have been the time of arrival on the true course to which it has been held by Chase, Sjogren and Brackett in succession.

At the same time that Nebraska first set out to give some elementary instruction along agricultural engineering lines, some other institutions, notably Minnesota, were dealing somewhat similarly with some of the same subjects. Usually the work was under direction of agronomy or farm management departments, whereas at Nebraska it was wholly in the hands of engineers. I doubt if the forward look was anywhere more nearly in line with later development than it was there.

[1]Agent, division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture. Hon. Mem. A.S.A.E.

The "Quadrangle" of the College of Agriculture, University of Nebraska. The agricultural engineering building is the one in the center of the background. At this school, however, the professional A. E. course is under the engineering college

Iowa State College has the distinction of putting into effect the first four-year curriculum, giving the first agricultural engineering degrees and turning out the greatest number of graduates. Nebraska, in second place in this respect, consoles herself with the reflection that Davidson handled the Iowa job and that he got his first outlook and inspiration at Nebraska.

Here may be the place to remark the youth of the men who finally assumed leadership in agricultural engineering and were principal factors in greatly accelerating the pace of its development. Davidson and Chase graduated in mechanical engineering in 1904. Within three or four years their names were inseparably associated with agricultural engineering. They addressed themselves at once to the task of putting the work on a professional plane and of extending its benefits to all in position to receive them. They were prime movers in the organization of the American Society of Agricultural Engineers, established advantageous connections on all sides, and in every way made themselves effective in the enterprise of directing and expediting the development of agricultural engineering.

The A.S.A.E. : 1906-1931

By Raymond Olney[1]

To RECORD its history from the actual beginning, it would seem that a national organization to represent agricultural engineers first appeared, in embryo, at an informal conference at the University of Illinois late in 1906. But the American Society of Agricultural Engineers was not formally organized until the meeting held December 27 and 28, 1907, in the agricultural engineering building at the University of Wisconsin. On page 182 is a pictorial record, lacking but three of being complete, of the attendance at the Society's first meeting at Madison. At the second annual meeting held at the University of Illinois, Champaign, in December 1908, the Society officially designated seventeen of its members as "Charter Members"—H. M. Bainer, Wm. Boss, L. W. Chase, B. B. Clarke, F. R. Crane, J. B. Davidson, R. M. Dolve, John Evans, C. I. Gunness, E. W. Hamilton, M. L. King, W. M. Nye, C. A. Ocock, H. W. Riley, P. S. Rose, E. A. White and J. G. Wynn. Clarke and King are deceased, and Crane, Dolve, Evans, Hamilton, Nye and Wynn are no longer members.

At the Madison meeting, Jay Brownlee Davidson was elected as the Society's first president; C. A. Ocock was chosen first vice-president; F. R. Crane, second vice-president; L. W. Chase, secretary; and W. M. Nye, treasurer. (Brief biographies of A.S.A.E. past-presidents, in the order in which they served, follow on pages 187, 188 and 189.)

At its first meeting a constitution and by-laws was also adopted, and A.S.A.E. started on its way a full-fledged national engineering society. And viewing this event from a quarter-century perspective, well may we say "They builded better than they knew." The Society has since grown and prospered—not phenomenally, but at least satisfactorily, if we accept the opinions of many of its members. Today it stands as an organization of which its founders are genuinely proud.

Due to the determination, initiative, far-sightedness and other contributing qualifications of its sturdy group of founders, A.S.A.E. got away to a good start. An impressive and fairly comprehensive list of technical papers on agricultural engineering subjects featured its first meeting. The publication of these papers and the accompanying discussions constitutes Volume 1 of the Society's "Transactions."

* * *

It will be of special interest to A.S.A.E. members just now to recall that at the Society's second annual meeting in 1908, L. W. Chase recommended the appointment of a committee to investigate the subject of a bureau of agricultural engineering in the U. S. Department of Agriculture, and a committee including Davidson, Riley, and Bainer was named. The records show that almost each year when the Society met, there was more or less agitation for the establishment of such a bureau. In fact, the project was being followed up more intensively all the time. It is now a matter of history that these efforts of the Society culminated in this year 1931 in the final step necessary to make the Bureau of Agricultural Engineering a reality.

[1]Secretary-Treasurer, American Society of Agricultural Engineers. Mem. A.S.A.E.

While the original thought in the minds of the founders of the Society seems to have been an organization to serve primarily the particular interests of college teachers of agricultural engineering, this idea appears to have early given way to that of encouraging closer contact, understanding and cooperation between agricultural engineers in college and industry, as the logical means of insuring well-rounded progress in developing the various phases of engineering as applied to agriculture. The records show that from the start more and more engineers in commercial and industrial positions joined the Society's membership ranks, and, what is more, they contributed generously and ably to the valuable fund of agricultural-engineering literature then in process of building.

* * *

By 1914, the record shows, the correspondence and other work of the Secretary's office had increased to such an extent that it was necessary to employ a combination clerk and stenographer for half time. Membership was increasing at a consistent rate, and correspondence was getting substantially heavier. Likewise the Transactions had greatly increased in volume of contents, requiring more time to publish them.

The Society was most fortunate in the early years of its existence to have members who possessed such a deep personal interest in and enthusiasm for the cause of agricultural engineering and who gave so cheerfully and generously of their time and energies—without pay, mind you — to serve the organization in the capacity of secretary. Here they are, in the order in which they served: L. W. Chase, E. W. Hamilton, J. B. Davidson, C. O. Reed, I. W. Dickerson, F. M. White, C. K. Shedd, H. C. Ramsower, F. W. Ives, and J. B. Davidson. F. P. Hanson was appointed assistant secretary, on salary, July 1, 1920, and was made secretary January 1, 1921, serving until November 1 of that year when he resigned. He was succeeded by the present secretary, who took over the work on a part-time basis, which arrangement continued for nearly four years.

The Society's need of a full-time secretary had been agitated for a number of years, and the objective seemed about to be realized when, in 1920, Mr. Hanson was appointed assistant secretary and later secretary, but the post-war business depression that began to set in almost immediately following this appointment made it necessary, on account of reduced revenues, to abandon the project temporarily. However, the Society's journal, Agricultural Engineering, was showing a gradually increasing revenue from advertising, until the point was reached at which the Council felt the Society could finance a secretary on a full-time basis, and such an arrangement was effected August 1, 1925.

* * *

Very early in Society history, members and committees began contributing much, in the way of individual and group effort, to the development of the farm tractor. The Transactions contained many technical papers on the subject, and a great deal of attention was given to such acti-

vities as the Winnipeg Motor competition and the tractor demonstrations. In fact, at the request of the Tractor and Thresher Manufacturers Association, a committee of the Society drafted a set of rules for tractor demonstrations which was approved by manufacturers and used in connection with the eight national tractor demonstrations in 1916. At several of these demonstrations brake and drawbar tests of tractors entered were made, usually under the supervision of the agricultural engineering department of the agricultural college in the state in which a demonstration was held. By 1918 the Committee on Tractor Testing and Rating had drafted Class A and Class B Tractor Demonstration Rules, which were extensively used and for which occasional requests for copies are still received. This work on the part of individual A.S.A.E. members and committees paved the way for the development and adoption later of the A.S.A.E. Standard Tractor Testing and Rating Codes.

* * *

The first regional or section meeting of A.S.A.E. members appears to have been held at Auburn, Alabama, June 26 to 29, 1917. This meeting seems to have been the one at which the Southern Section, the Society's first geographical section, was organized. The section did not hold more than two or three meetings, and due largely to the size of territory it included and the consequent difficulty of getting attendance at its meetings, it was temporarily discontinued. It was revived again late in 1926, but this time confined its territory to southern states east of the Mississippi River. The Pacific Coast Section was organized in December 1924, the North Atlantic Section in April 1925, the Southwest Section late in 1925, and the North Central Section in May 1927.

* * *

Following the close of the World War the Society took a new lease on life. There were a number of standards conferences. There was considerable activity to bring about close cooperation between groups of men represented by our Society membership and by the association representing the farm equipment manufacturers. The Society was represented at what was probably the first conference of engineering societies to consider what later evolved as American Engineering Council, of which A.S.A.E. is a charter member and on which S. H. McCrory was our first official representative. July 1, 1920, is an important date in Society history, for on that date began the employment of an assistant secretary on salary—Frank P. Hanson. In September of the same year members took the most momentous step since the founding of the Society—the establishment of a technical journal.

* * *

For about seven years after the American Society of Agricultural Engineers was organized, its only publication was the Transactions. In July 1914 a news sheet called the "Bulletin" was published occasionally during the year. Under the name "News Letter," this news sheet was expanded in January 1916 and published at more frequent intervals. It was discontinued when the Society's official journal, Agricultural Engineering, was started in September 1920.

To F. N. G. Kranick then president and J. B. Davidson then secretary of the Society belong the lion's share of the credit for the launching of our Journal, Agricultural Engineering. It was too early then to foresee the serious postwar business depression that was to follow, or the Journal might not have been started until years later. It was of course a financial liability from the start, or until 1924 when it first began to return a profit. It must be said, however, that Agricultural Engineering was a distinct professional asset from the first, and from that standpoint, even in the face of a business depression, it was established none too early.

The first four numbers of Agricultural Engineering (September to December 1920) were published at Ames, Iowa. Beginning with the issue of January 1921 the publication of the Journal was transferred to St. Joseph, Michigan, where, with the exception of two years, it has since been published.

The organization of the Society into specialized groups or divisions began to take place in 1920 with the formation of the Land Reclamation Division and the College Division (or "Sections" as they were at first called). The Power and Machinery Division and the Structures Division were organized soon thereafter. (The Rural Electric Division was organized in 1925.) The appearance of the divisions resulted in the grouping of subjects presented on the annual meeting program according to the interests of these groups. In fact, their activities increased rapidly following the World War, and at the annual meeting in 1922 it was necessary to hold simultaneous sessions of four groups, part of the time, in order not to prolong the time of the meeting beyond the usual three days.

It was becoming apparent, however, that, even with the paralleling of technical sessions at the annual meeting, it was not possible to give some groups all the time they needed to present the results of development in their respective fields, and in December 1924 the first technical division meeting, separate from the annual meeting, was held by the Power and Machinery Division at Chicago. A meeting at the same time of the year and at the same place has been held each year since. In February 1926 the Structures Division sponsored its first meeting separate from the annual meeting, which was called the National Farm Homes Conference. The Rural Electric Division held its first midyear technical meeting at Chicago in December 1928; however, at its business session during the annual meeting in 1930, this Division decided to discontinue holding technical meetings at Chicago in December and instead to hold them once a year in connection with the annual meeting. The Land Reclamation Division presented its first technical program, in addition to its usual program at the annual meeting, at a meeting held at Kansas City in December 1929.

The Society has given all possible encouragement to its technical divisions, the wisdom of which is being more and more recognized as the influence of these group activities on agricultural engineering development and Society progress become more apparent. The history of any branch of engineering is that it becomes more highly specialized as it develops. This tendency in agricultural engineering became more pronounced following the World War, of which the organization and growth of these divisions in A.S.A.E. is a logical result. However, agricultural engineering is still a very new development, as compared with most of the better known branches of engineering, and this tendency to greater specialization among our membership has scarcely more than begun.

In hastily scanning the first quarter-century history of the American Society of Agricultural Engineers, to one who has been active in its affairs for the past twenty years and who has played a part in directing the activities of the organization during the past ten years, the most outstanding thing about it—in fact, its greatest achievement — is its members. The Society was exceedingly fortunate in its founders — men of exemplary character, of high professional ideals, of clear vision, and of sound judgment. On a foundation of such qualities was the organization established, and men of like characteristics have been attracted to it. The Society from the start elected to build its membership more on the basis of quality rather than of quantity, and judging from the many fine comments heard at our meetings, by persons outside its membership ranks, that policy of careful selection has been more than justified.

With such a membership as a background the Society enters the next 25-year period with much in its favor. The past has been largely a struggle for recognition of what agricultural engineering and agricultural engineers have done and are capable of doing — how they fit into the agricultural picture — and much has been achieved in this direction. In the future not only the opportunities but the responsibilities as well will be much greater than heretofore, for far larger problems loom ahead. But agricultural engineers will be equal to every task.

Our Presidents

THE membership of the American Society of Agricultural Engineers has every reason to be proud of its presidents. On the whole they have been leaders in the particular phases of the work they represent, and generally recognized as such. The Society was organized by men comparatively young in years. Of its list of twenty-five past-presidents, only two are deceased (McCormick and Ives), and only three (Wynn, F. M. White and Curtis) are no longer members of the Society. On this and the two succeeding pages will be found the faces of all the past-presidents who are still members, with the exception of two. Following, in chronological order, is a brief account of the men who have served A.S.A.E. in the capacity of president:

Jay Brownlee Davidson, head of the newly organized department of agricultural engineering at Iowa State College, an aggressive leader in bringing about the organization of the American Society of Agricultural Engineers, was elected by the other charter members to be its first president during 1908. Since then in various official and unofficial capacities he has worked continually for its advancement, as an organization vital to the technical and educational progress of the profession. His thought for it is reflected in the extensive and diverse achievements of his long and almost continuous service as head of the agricultural engineering department at Iowa State College, but, above all, in the large number of successful agricultural engineers who look back to him as the source of their initial professional training and inspiration.

John G. Wynn, who at that time held the position of engineer of the Wayne Electric Works, at Madison, Wisconsin, was elected to succeed Mr. Davidson, as the second president of the Society and to serve during the year 1909. He was one of the enthusiastic organizers of the Society and contributed much of the energy needed at that time to get the young organization under way. However, he soon took up work in a field unrelated to agricultural engineering and is no longer a member of the Society.

Philip Sheridan Rose, of the Clarke Publishing Company, held the office of president of the Society during 1910. When he helped organize and became a charter member of A.S.A.E., he had for several years successfully pioneered the cause of agricultural engineering at North Dakota State College. During the interim before his election as president, he shifted his field and medium of teaching from the college and its agricultural engineering courses to journalism and a farm engineering periodical. Throughout his long journalistic career and in his present position as editor of "The Country Gentleman," he has not drifted away from the Society or the cause to which he devoted his earlier years, but has continued his pioneering leadership and increased his effectiveness as, in fact, an extension agricultural engineer.

Charles Albert Ocock was head of the department of agricultural engineering at the University of Wisconsin and one of the hosts to A.S.A.E. when it organized there in 1907. He was chosen its fourth president, to fill that office during 1911. He and J. B. Davidson had talked about such an organization as early as the spring of 1905. He left the University of Wisconsin to take charge of the plant building engines for Avery tractors at Milwaukee, a position which he held until the manufacture of that line of tractors was discontinued. Since then he has been connected with the J. I. Case Company.

Howard Wait Riley, head of the department of farm mechanics at New York State College of Agriculture at Cornell University, served the Society as its fifth president in 1912. Raised on a New Jersey farm, trained in mechanical and electrical engineering at Cornell University, with several years of engineering experience in industry, he had organized and taught farm mechanics courses at his alma mater only a few months, when the organization meeting of A.S.A.E. was called, and he became one of its charter members. The growth of his work to its present status, in which he is professor and head of a large and active department of agricultural engineering, is distinguished by the close contact he has maintained with New York farmers and their immediate engineering problems.

Jay Brownlee Davidson

Philip Sheridan Rose

Charles Albert Ocock

Howard Wait Riley

Leon Wilson Chase, head of the pioneer department of agricultural engineering at the University of Nebraska, a department which he had developed following the initial impetus of O. V. P. Stout and J. B. Davidson, is sixth in the line of A.S.A.E. presidents (1913). Educator, research engineer, administrator, holder since 1914 of professional degrees in both agricultural and mechanical engineering, member of other technical, honorary and trade organizations, author and lecturer, co-developer of the Nebraska Tractor Tests, and industrialist in his present capacity as president and general manager of the Chase Plow Company, he has extended the good name and influences of the agricultural engineerilng profession far and in many directions.

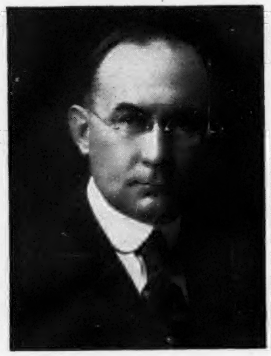
Wallace Forrest MacGregor, mechanical engineer, J. I. Case Company, was elected seventh president of A.S.A.E. (1914). He was the first man not a charter member, and the first agricultural engineer in the farm equipment industry to be so honored. After earning the degree of mechanical engineer in five years at the University of Wisconsin, he went directly to the Case organization to begin his long and successful career in designing and developing farm machinery. His particular field in the company, he has served continuously, has been heavy machines, including threshers, combines, steam engines, tractors, hay balers and road machinery.

Harry Hayes Musselman, head of the department of farm mechanics at Michigan State College, took over the controls as president of A.S.A.E. in 1915. He is another one of the farm-reared, engineering-trained men who, after a brief engineering experience in industry, was called back to his alma mater to initiate instruction in farm mechanics. In addition to teaching, administering his department, getting its name changed to "department of agricultural engineering," and starting a professional course, he has been active in the development of the marl resources of Michigan, dealing with its cut-over and land-clearing problems, promoting rural electrification and controlling the European corn borer.

Frank M. White, professor of agricultural engineering, University of Wisconsin, succeeded Mr. Musselman in the highest office of the Society (1916). An agricultural graduate of the University of Illinois, he earned his master's degree at the University of Wisconsin while employed there as assistant agricultural engineer. Mr. White is no longer a member of the Society, being engaged in another field of endeavor.

Edmund B. McCormick, agricultural engineer, U.S.D.A. Office of Public Roads and Rural Engineering, tenth president of the Society (1917), brought to the office a wide range of experience as a graduate of Illinois State Normal College, a railroad machinist apprentice, a graduate in mechanical engineering from Massachusetts Institute of Technology, machinist, builder, professor of mechanical engineering, dean of engineering (Kansas State Agricultural College) consulting editor of a series of books on agricultural engineering, and agricultural engineer with the U.S.D.A. Mr. McCormick passed away in January, 1922.

Leon Wilson Chase



Harry Hayes Musselman

Daniels Scoates

Frank N. G. Kranick

Daniels Scoates, head of the department of agricultural engineering, Mississippi A. & M. College, became the Society's president at the beginning of its second decade (1918). While a student in civil engineering at Iowa State College, he became interested in agricultural engineering and affiliated with the American Society of Agricultural Engineers. Upon graduation he went to Montana State College to begin his career as a teacher in agricultural engineering, but was soon called to larger responsibilities at the Mississippi institution. In 1919, with several years of successful teaching and research administration, a professional degree in agricultural engineering from his alma mater, and a term as president of A.S.A.E. to his credit, he took charge of the department of agricultural engineering at the A. & M. College of Texas. In connection with his work as an educator he has shown a strong leaning toward authorship, having written many short articles, several laboratory manuals, and, with Q. C. Ayres, a book on land reclamation.

Raymond Olney, editor of "Power Farming," stands next on the presidential roll (1919). He was a graduate in mechanical engineering from Cornell University, with additional training and a degree in agricultural engineering from Iowa State College. In November 1921 he became secretary of the Society and editor of AGRICULTURAL ENGINEERING, its comparatively new publication, in addition to his regular work. Since 1923 he has also served as treasurer of the Society.

Frank N. G. Kranick, another engineer in the farm equipment industry, received the presidential gavel from Mr. Olney (1920). Trained by private instruction and experience, he has been in the farm equipment and related industries since the beginning of the present century. He has made engineering studies of farm machinery in the field practically all over the United States and in many parts of South America and Europe. During his term as president the Society grew rapidly. He sponsored the publication by the Society of an official journal, and it was largely through his efforts that AGRICULTURAL ENGINEERING came into existence in September 1920. This has probably been the most important single step in the development of the Society since its organization.

Earl A. White, technical editor of "Farm Implement News," was president number fourteen (1921). At the time that he helped to organize the A.S.A.E., he was a recent agricultural graduate of the University of Illinois and a teacher in its department of farm mechanics. Bent on further preparation for what he had decided should be his life work, he went to the University of Wisconsin to earn his master's degree, and thence to Cornell University for more advanced study. There he distinguished himself in a fundamental research on plow bottoms, for which he was awarded a distinguished degree, doctor of philosophy in agricultural engineering, the first of its kind ever given. Subsequent educational, editorial and professional work resulted in his being selected as director of the Committee on the Relation of Electricity to Agriculture when it was organized in 1923. Here his leadership, together with his faith in other agricultural engineers, have carried them successfully into a new field.

Arthur J. R. Curtis, manager of Portland Cement Association's cement products bureau, was the next man honored with the presidency (1922). A graduate mechanical engineer, thrown in contact by his work with farm structures and reclamation problems, with long experience as a member of the Society, enthusiastic, aggressive and able, he proved an ideal leader during the continuing post-war agricultural and business depression. The Society was less seriously weakened by resignations than many other similar organizations. During the year it wiped out a substantial deficit by exercising economy, and at the same time the publication of its "Transactions" was brought up to date. Mr. Curtis is no longer in agricultural engineering work or a member of the Society, but the profession is still the beneficiary of his having been so engaged for years.

Frederick Alfred Wirt

Oscar Warner Sjogren

Emil Wilhelm Lehmann, professor and head of the department of farm mechanics at the University of Illinois, was chosen president to succeed Mr. Curtis (1923). A recruit from electrical engineering he went to Iowa State College to teach in the agricultural engineering department, while earning in it his bachelor's degree. The University of Missouri, on the lookout for a man to take charge of a new agricultural engineering department in 1916, found him. Four years in Missouri and one as agricultural engineering editor of "Successful Farming" prepared him for the position at the University of Illinois which he holds at present.

William George Kaiser

Samuel Henry McCrory, chief of the division of agricultural engineering, U.S.D.A. Bureau of Public Roads, followed in the footsteps of his former chief, E. B. McCormick, by serving as president during the Society year 1923-24. He occupies a particularly strategic position in the agricultural engineering world. As chief executive of the largest single agricultural engineering research and extension organization in the country, he guides his division with a constant view to its place in the work of the U.S.D.A., to the engineering needs of agriculture and to the ideals and ambitions of his profession. His profession has consistently recognized the importance of his work and urged that the government increase his facilities and raise his division to the status of a bureau. This has been granted and July 1 the federal agricultural engineering work will come into its own.

Frederick Walter Ives (1884-1924), professor and head of the department of agricultural engineering at Ohio State University, was elected president for the year 1924-25. However, on his way home after the 18th annual meeting at Lincoln, at which he had taken over his duties as president, he was fatally injured in a railroad accident. The agricultural engineering profession, robbed of the leadership he might have given it, cherishes the memory of his pleasant personality, sterling character, energy and ability.

Earl A. White

Emil Wilhelm Lehmann

Samuel Henry McCrory

Harry Bruce Walker

Oliver Brunner Zimmerman

William Boss

Robert W. Trullinger

Harry Bruce Walker, professor and head of the department of agricultural engineering at Kansas State Agricultural College, as first vice-president of the Society had the responsibilities of the presidency thrust upon him unexpectedly and with a shock by the untimely demise of Mr. Ives. He faithfully carried out the plans and policies of the man whose place he filled. In his experiences following graduation as a civil engineer, drainage and irrigation work appealed to him most and led to his heading the agricultural engineering work in Kansas from 1921 until 1928, when he accepted his present position as head of the agricultural engineering division of the University of California. Since becoming an agricultural engineer in 1921, he has been a consistent and highly effective worker for the advancement of the profession. In 1929 he represented the Society at the World Engineering Congress in Tokio.

Frederick Alfred Wirt, advertising manager of the J. I. Case Company, president for the year 1925-26, led the Society to the close of its second decade of existence and the beginning of a new era in its advancement. It was quite largely through his planning and initiative that the Society was enabled, in the summer of 1925, to employ a full-time secretary. Mr. Wirt's contributions to the advancement of agricultural engineering began in 1913, when he received his bachelor's degree in civil engineering at the University of Nebraska and went to Kansas State Agricultural College to take charge of its work in farm mechanics. They have continued throughout his subsequent career in teaching and in farm machinery sales and advertising work. In recent years he led the Society in its efforts to have a bureau of agricultural engineering established in the U.S.D.A.

Oscar Warner Sjogren, chairman of the department of agricultural engineering, University of Nebraska, was honored with the presidency of the Society (1926-27), in recognition of both his long past service to it and his ability to lead it on to further achievement. It can be accurately said that he has grown up with the agricultural engineering profession, for back in 1909 when farm power and machinery progress was still in the "blacksmithing" stage, he graduated from the school of agriculture at the University of Nebraska and became a member of its faculty as instructor in blacksmithing. From this position he went into the college of engineering, in the comparatively new agricultural engineering department, as student and student assistant, and rose by successive steps to its chairmanship. He moved to California in 1929 and took up his present work as agricultural engineer for the Killefer Manufacturing Company.

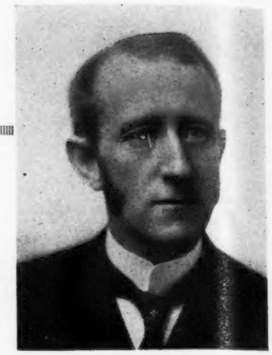
Oliver Brunner Zimmerman, assistant to manager of the engineering department, International Harvester Company, in charge of research and standards, received the president's gavel from Mr. Sjogren at the St. Paul meeting of the Society, to wield for the year 1927-28. Having earned his bachelor's degree in mechanical engineering in 1896 and his professional degree in 1900, he had a long list of mechanical and agricultural engineering experiences and achievements to his credit before he became associated with the International Harvester Company and settled definitely on an agricultural engineering career which has since been interrupted only by the war. Then successively as Captain and Major of Engineers he took an active part and won high honors in the scientific and development work which helped to bring victory. Since then he has been commissioned as lieutenant-colonel in the Officers Reserve Corps. His great experience, many connections, and active interest in its work have made him especially valuable to the Society.

William Boss, professor and chief of the division of agricultural engineering at the University of Minnesota, was the choice of the Society to lead it through the year 1928-29. He is another of the pioneers who helped bring the agricultural engineering profession into existence. He developed and taught the first courses in farm mechanics offered at the University of Minnesota. Although he was unable to attend the organization meeting of the Society, he prepared a paper which was presented there, and became one of its charter members. Largely through his efforts the University of Minnesota was provided with a suitable agricultural engineering building in an early day when such facilities were rare. After being away for several years, he returned in 1918 to again direct its agricultural engineering activities. In 1925 his division inaugurated a professional course.

William George Kaiser, agricultural engineer and assistant manager of the cement products bureau, Portland Cement Association, in charge of all farm promotion work, is junior past-president of the Society, having succeeded Mr. Boss in office (1929-30). He is one of J. B. Davidson's proteges of the class of 1914. After a few years of research work at Ames, as assistant agricultural engineer in the Iowa Agricultural Experiment Station, the Portland Cement Association put him to work in its extension division as farm structures expert. In another few years he was awarded his professional degree and soon later stepped up to his present position. He has always been active in the structures work of the Society, was instrumental in organizing its Structures Division, and has twice served as its chairman.

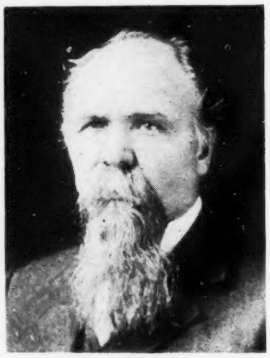
Robert W. Trullinger, assistant in experiment station administration (senior agricultural engineer), Office of Experiment Stations, U.S.D.A., is president of the Society this year (1930-31). Soon after his graduation from Iowa State College in 1910, as a civil engineer, he connected with the Office of Experiment Stations as a specialist in rural engineering. Agricultural engineering research was in its infancy then. His contributions to its literature and his activity in showing experiment station workers and directors the way to more and better agricultural engineering research, have had no small part in building the work up to its present standard and volume. His close contact with it has made him the profession's foremost authority on research. In addition he has kept in close contact with the profession through the Society and has always been ready to give it the benefit of his viewpoint and experience.

Our Honorary Members



Arthur O. Fox

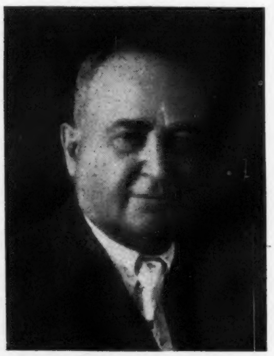
Arthur O. Fox is one of the first two honorary members of the American Society of Agricultural Engineers elected at its second annual meeting (1908). In the first president's annual address presented by J. B. Davidson at that same meeting, we find the following statement relative to the organization of A.S.A.E., "Perhaps no one influenced the formation of an engineers' society more than Mr. A. O. Fox, of the Northern Electric Company, who is intensely interested in the work of the agricultural engineer." He was then president and general manager of the Northern Electrical Manufacturing Company and perhaps had a premonition of the part agricultural engineers were to play in a then unheard-of field, rural electrification. For some years Mr. Fox has been president of General Laboratories, Madison, Wisconsin.



Frank Hiram King

Frank Hiram King (1848-1911), the other honorary member elected in 1908, was a teacher, scientist and author of long experience when, in 1888, he accepted the chair of agricultural physics in the University of Wisconsin, the first of its kind in the country. It led him into fundamental researches on the water requirements of crops, irrigation and drainage, the movement and conservation of soil water, protection of sandy soils from wind erosion, windmills as motors, the construction and ventilation of farm buildings, the construction of silos and the preparation of silage, and similar subjects. In 1901 he was appointed chief of the division of soil management in the U.S.D.A. Bureau of Soils. After a few years, however, he returned to his home at Madison to devote his time to writing and to occasional trips to study agriculture in various parts of the world. In 1910 the University of Wisconsin conferred on him a well-deserved honorary degree of doctor of science. His work laid a solid foundation for subsequent agricultural engineering research.

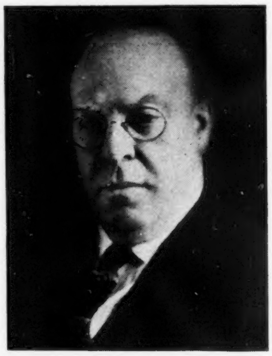
Bascom B. Clarke (1852-1929) was instrumental in organizing the American Society of Agricultural Engineers, became one of its charter members, and a few years later was elected to honorary membership. With earlier experience both as a publisher and as a farm equipment salesman for a foundation, he started, in 1898, the publication "American Thresherman." He served continuously as its editor and publisher until the time of his death. In addition he was a philanthropist and a thirty-third degree Mason. He has been aptly called "a modern Benjamin Franklin." Of his part in naming the Society, J. B. Davidson says (page 183) " . . . . after listening to the discussion (he) made one of the tempestuous speeches he was accustomed to deliver to threshermen's conventions, urging that agricultural engineering was a high calling and that those present should live up to their opportunity. 'B.B.' won the group, and it was voted that it should be a 'society of engineers.' "



Bascom B. Clarke

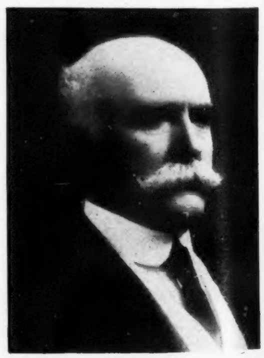
John Barton Bartholomew was elected to honorary membership in the Society in 1921 in recognition of his contributions to the application of engineering to agriculture, during his long service with the Avery Company and during his connection with the Society as an active member (1908-1921). A farm boy, he entered the employ of the Avery Company to do odd jobs and rose successively to positions as service man, salesman, branch house manager, sales manager, vice-president and president. He also invented the Bartholomew self-feeder, was co-inventor of the pneumatic wind stacker and the steam-lift plow, and was the first to use renewable inner cylinder walls and adjustable main bearings for tractors. He passed away in May, 1925.

Joseph Doty Oliver was also added to the Society's roll of honorary members in 1921. The son of James Oliver, inventor of the chilled plow, after schooling at Notre Dame and De Pauw Universities he entered his father's factory to learn the plow business. That was more than sixty years ago. He was largely responsible for popularizing the chilled plow and other inventions of his father and for building up the business. When his father died in 1908 he became directing head of the Oliver Chilled Plow Works. When the company reorganized and merged with several other companies in 1929 to form the Oliver Farm Equipment Company, he was elected chairman of the board of directors, and is still active in that capacity. Early in August of this year he will be 81 years of age.

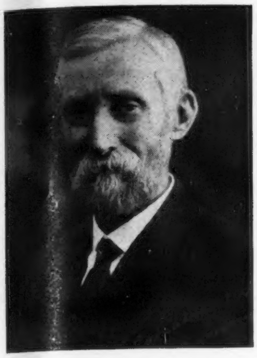


John Barton Bartholomew

William Louden, founder of the Louden Machinery Company, another of the versatile trail blazers who invented, engineered, manufactured, demonstrated and overcame tremendous sales resistance to give farmers equipment by means of which they might increase their productivity and material welfare, was made an honorary member early in 1921. It is now sixty-four years since he invented his first hay carrier, an apparently simple device which has made possible larger and higher barns and elim-



Joseph Doty Oliver

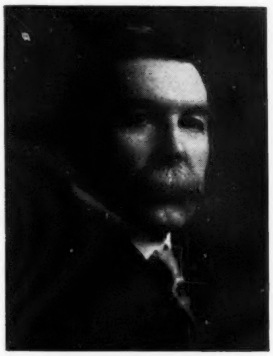


William Louden

inated the elevated barn driveway and bridge. From 1914 to 1921 he was an active member of the Society, and served on its Council for three years. Mr. Louden is now 90 years of age, a grand old man who has lived to see his inventions come into wide use.

Willard Austin Van Brunt was voted into the Society's honorary membership in 1922 in consideration of his invention and development of improved small grain drill features which have influenced seeding practice as the steel plow influenced tillage and as the reaper influenced harvesting. In 1861, he started with his father building broadcast seeders. This led to his invention of the first fluted force-feed, the Van Brunt adjustable gate feed, an improved drill shoe, an epoch-making single-disk drill with dustproof chilled bearing and toe scraper, and other refinements on seeding machinery. Upon this foundation of engineering progress his business prospered and grew through several reorganizations which culminated in its becoming a branch of Deere and Company. For several years he has also had the distinction of being one of the Society's few octogenarians.

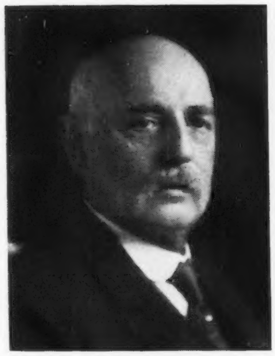
Elwood Mead studied both agriculture and civil engineering at Purdue University long before courses in agricultural engineering was thought of, earning a certificate of graduation in agriculture and a bachelor's degree in civil engineering in 1882. In his long association with reclamation work, beginning with drainage surveys made while he was still an undergraduate student; continuing upward through advanced training and a long series of federal and state engineering and teaching positions; and culminating in his present dominion over the U. S. Bureau of Reclamation, he has probably done more to advance the science and cause of land reclamation than any other one man. Purdue University honored him with the degree "doctor of engineering" in 1904, and the University of Michigan with the "doctor of laws" in 1926. O. V. P. Stout credits (page 184) Dr. Mead as being the source of a large share of his initial inspiration.



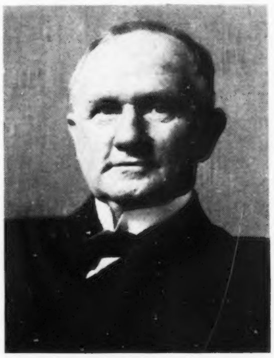
Samuel Fortier

Oscar Van Pelt Stout

Samuel Fortier's engineering accomplishments in developing the land and water resources of the states of the West resulted in his election to honorary membership in 1923. From his native Quebec (Canada), where he worked and saved to be able to complete a course in civil engineering at McGill University, he went west in 1885 to build wooden bridges and route the Denver and Rio Grande Western Railroad over the continental divide. Within a year, however, he became first assistant engineer for the Denver Water Company and found the work more to his liking. Since then he has designed and directed construction on many large water works principally for irrigation, acted in a consulting capacity on numerous others, directed irrigation research, studied the conditions of western agriculture and written texts and technical articles on irrigation and related subjects.



Willard Austin Van Brunt



Elwood Mead

Oscar Van Pelt Stout was elected to honorary membership in the Society in 1928, following several years of active membership during his connection with irrigation work since the World War, and following a previous engineering career dating back to 1886. His early influence on the development of agricultural engineering instruction at the University of Nebraska is modestly stated in his article in this issue (page 184). The germ of agricultural engineering inspiration and foresight planted in him by Dr. Mead lived, grew, and was caught up by many of Dean Stout's students, four of whom—J. B. Davidson, L. W. Chase, F. A. Wirt and O. W. Sjogren—have served as presidents of A.S.A.E. During the World War he was commissioned a Major in the Engineer Reserve Corps. Since then he has been engaged in federal and private irrigation engineering practice.

John J. Glessner is the most recent addition to the Society's super body of honorary members. He is another survivor and representative of a group of able, pioneering executives of the implement business when, in the years following the Civil War, it was helping agriculture to conquer the West. At the start of that foundation period he was employed in the office of Warder and Childs, Springfield, Ohio, manufacturers of hand rake reapers, plows and cotton seed planters. His ability and application to his work immediately won the confidence of his employers, resulted in his becoming a member of the reorganized firm three years later and started him in a career in which he was an important factor in building the business through expansion and a series of reorganizations, into the International Harvester Company of today. He has been a principal in the design, manufacture and marketing of farm implements longer than any known living man. At the age of 88 he is still active as a director in the International Harvester Company and a firm believer in the possibilities of civilization in the present and future.

John J. Glessner

Agricultural Engineering Research

By R. W. Trullinger[1]

RESEARCH in agricultural engineering has undergone a very gradual but sound development during the past twenty-five years, growing from almost nothing to a strong program numbering considerably more than three hundred major projects. Early in that period the requirements of the agricultural industry for engineering were found to be peculiar and exacting and often to differ considerably from those of other industries. Naturally, many inadequacies, from the standpoint of the industrial requirements of agriculture, began to appear in the knowledge available from the older branches of engineering. There was, therefore, an early tendency to resort to investigation and research to produce the desired knowledge.

The earlier attempts at research in agricultural engineering met with little sympathy from either engineering or agricultural administrators. However, certain far-sighted agricultural administrators eventually began to recognize the importance of the work and give it at least moral support. With a few outstanding exceptions, therefore, research in the subject began in agricultural experiment stations where the research equipment was naturally not, in general, adapted to engineering research. The workers in agricultural engineering were thus able to start the work, but lacking support from the engineering institutions, were virtually forced to build their technique and equipment new from the ground up.

These handicaps account for the slow growth of the research program, and explain why the early attempts at research in agricultural engineering were somewhat crude. Lacking specific agricultural requirements and definite objectives, and handicapped by inadequate technique and equipment, the pioneers naturally resorted to simple, comparative tests of mechanical, structural, and hydraulic methods and equipment in service. This procedure persisted for several years in some lines.

Such tests seem to have served a very useful purpose, however. They satisfied certain immediate, general needs. They also clarified the field for research in certain features of the subject and brought to light important problems and knowledge requirements of a more specific character. Similar tests are often used today to clarify new fields of agricultural engineering research.

As progress was made agricultural engineering, as a research subject, became better understood in agricultural experiment stations. An attitude of sympathetic encouragement was adopted which resulted, in some instances, in the provision of more adequate research facilities and personnel. Cooperation also was offered by supplying specific basic agricultural requirements. This not only made possible the extensive economic application of available engineering principles to agriculture, but virtually forced efforts toward the material modification of many of them.

In time these efforts began to result in the development of entirely new principles of a distinctly agricultural engineering character. In addition, agricultural engineering problems gradually aligned themselves in certain general fields. These included (1) farm power and machinery, (2) farm structures, (3) land reclamation and (4) rural electrification, and agricultural engineers now specialize in specific features within these four fields.

In the power and machinery field economy in production and increased efficiency per agricultural worker resulted in general from the early efforts to mechanize agriculture. However, modern investigations have shown that it is in the important specific details of mechanical equipment and power operations such as in plowing, cultivating and harvesting that engineering research can introduce further permanent cost-saving improvements. Thus the provision of laboratories and technique for the study of soil dynamics and the mechanics of tillage has resulted in the gradual displacement of the comparative field tests of available tillage machines. This has already yielded returns on the investment in the form of more efficient and economical tillage machinery and methods.

Much also has been accomplished in the development of draft machinery. The tractor, for example, in the earlier stages of its development, was frequently neither efficiently nor economically adaptable to the peculiar and sometimes very severe conditions of agricultural service. The technique of tractor research has changed, therefore, to permit development along certain specific fundamental lines, as well as of the complete unit. The tractor is now considered as a complex of several problems each requiring definite and limited study, and special research technique and equipment are being developed with which to solve them.

Developments of a similar character have taken place in the technique and equipment of research in harvesting and threshing machinery. Much was accomplished along cost-saving lines by the practical combination of the grain harvesting and threshing operations for example. However, in order to prevent power and grain wastage, modern research technique has isolated the basic mechanical and thermodynamic requirements for the proper cutting, threshing and artificial drying of grain.

In the field of farm structures attempts have been made to establish the specific agricultural requirements and the economic limitations for farm buildings. With this information it has been possible to progress from simple comparative tests of different animal shelters and crop storages to controlled fundamental studies of optimum internal housing conditions, structural soundness and durability, and economy and fire resistance.

In the field of land reclamation drainage investigations have been narrowed down from the broad general demonstration type of field drainage experiment of the earlier years to studies of the principles of soil hydraulics governing the movement of water through different soils under the influence of drainage equipment.

Similarly, the irrigation research has developed from the uncontrolled duty of water experiments to controlled studies aimed at establishment of the principles governing economical and efficient irrigation practices.

Studies of soil erosion and storm run-off prevention have progressed from the time-honored comparison of terracing methods to controlled studies of the features of engineering hydraulics and soil technology which govern erosion and run-off. The technique and equipment provide for both field and laboratory studies permitting the control of all physical and mechanical factors involved and their variation at will.

The recent widespread movement to introduce electricity into agricultural practices has opened up a new and voluminous field of research for agricultural engineers. While only in process of clarification and organization, it has the well-established background of the electrical industry at its disposal and already has made remarkable progress in lightening certain agricultural burdens.

Thus, of the several hundred research projects in agricultural engineering, many employ the most modern and improved technique and equipment. The tendency now is toward even greater refinement in the details of the methods and equipment of the agricultural industry to adapt them more uniformly to the needs of all classes and sizes of production. Herein lie the great research problems which constantly will confront agricultural engineers in the future. They will call for a research technique increasingly profound, precise, and capable of controlling the factors of experiment.

[1]Senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture. Mem. A.S.A.E.

Agricultural Engineering Education

By H. B. Walker[1]

TWENTY-SEVEN years ago the Board of Regents of the University of Nebraska[2] set aside $15,000 for buildings and equipment for the first organized work in agricultural engineering. J. B. Davidson[3], a graduate of that institution, was put in charge of the work under the direction of the mechanical engineering department. Thus a new type of applied science was introduced into our land-grant colleges and universities which today is recognized by forty-two of these institutions in the United States.

Other state colleges and universities which previous to 1910 followed the precedent of the University of Nebraska were Iowa State College and the University of Wisconsin in 1905, Michigan State College in 1906, Cornell University in 1907, and the University of Georgia, Washington State College, University of Minnesota and Mississippi A. & M. College in 1909.

It became apparent to some of the pioneer leaders in this field that educational efforts should not be limited to service courses to undergraduate agricultural students, but that an effort should be made to train men in the fundamental physical sciences as well as applied engineering courses in order that engineers so trained might render a technical service to the agricultural industry similar to engineering services in other industrial fields. Iowa State College graduated its first agricultural engineers in 1910. Nebraska offered a professional course the same year, and Kansas State College, the University of Missouri, and Virginia Polytechnic Institute followed somewhat later. By 1922 seven institutions were offering training in professional agricultural engineering; in 1925 there were 10; in 1929, 17; and in 1931 20 institutions reported an agricultural engineering curriculum.

The institutions now offering technical training in agricultural engineering are as follows: Alabama Polytechnic Institute, University of California, University of Georgia, University of Idaho, Iowa State College, Kansas State College, Louisiana State University, Michigan State College, University of Minnesota, University of Missouri, University of Nebraska, Oklahoma A. & M. College, Oregon Agricultural College, Pennsylvania State College, South Dakota Agricultural College, University of Tennessee, Texas A. & M. College, Virginia Polytechnic Institute, Washington State College, and the University of Wisconsin. The University of California and the University of Wisconsin offer such instruction as options in mechanical engineering.

Five of the institutions named have heretofore accounted for over 50 per cent of all students enrolled.

[1]Professor of agricultural engineering, University of California. Mem. A.S.A.E.

[2]Crawford, Robert P. "These Fifty Years," University of Nebraska, College of Agriculture, 1925.

[3]Now professor of agricultural engineering, Iowa State College.

The agricultural engineering building at University of California

These are listed in Table I showing the registrations for the years indicated.

Table I

Institution	Enrollment in Agricultural Engineering 1922	1925	1929	1931
Iowa State College	60	32	52	72
Kansas State College	38	34	56	63
University of Nebraska*	25	6	26	28
Texas A. & M. College	25	23	26	17
Virginia Polytechnic Institute	26	45	40	54
Totals	174	140	200	234
Totals for all Institutions	213	153	293	403
Percentage of total in 5 institutions	82	92	68	58

*Enrollment estimated from previous reports for 1931.

In 1929 all institutions reported 47 seniors and 23 graduate students and the estimate for 1931 is 55 seniors and 34 graduate students. Previous to January 1926, eight United States colleges and universities and one Canadian university had graduated a total of 268 men.[4] Thirty-seven per cent of these have remained in educational and research work; 15 per cent (approximate) are associated with the farm equipment industry; 5½ per cent are in the rural structural field; 7½ per cent in land reclamation; 16 per cent are operating or managing farm projects, and the remainder are in unrelated activities or are deceased.

The real influence of technical agricultural engineering training is just beginning to be felt in industrial agriculture. Early graduates were absorbed largely for educational work in the development of this field. Now, more are available for other employment. Graduates of recent years have been absorbed largely by the implement and electrical industries.

While the development of technically trained men for agricultural fields is now an accepted responsibility of the land-grant institutions, this does not constitute the only educational work in this field. From 1904 to 1928, 78,000[5] agricultural students have received instruction in some applied agricultural engineering course. During the school year 1928-29, 6660[6] students were enrolled in such courses, and in 1930-31 approximately 7300[6].

The growth of agricultural engineering education during the past 25 years is evidence of the usefulness of such training. As is often the case in applied science instruction much revamping of subject matter has been necessary. The tendency has been toward more training in the fundamental sciences, less of applied instruction, and more specialization in the particular engineering phases of agriculture such as dairying, electrification, power, structures, and land reclamation.

As time goes on, we may expect to see less differentiation in the fundamental engineering training of agricultural, mechanical, electrical and civil engineers, and no doubt greater emphasis will be placed on 5-year undergraduate courses and graduate instruction. It appears that the number of institutions offering technical agricultural engineering training is more than ample to meet the immediate demand for trained men. Further expansion seems undesirable, and a closer integration of agricultural engineering training with the older established engineering curricula will undoubtedly take place in the future.

[4]Walker, H. B. "Engineering as Applied to Agriculture," Paper 454, World Engineering Congress, Tokio, Japan, October, 1929.

[5]Davidson, J. B. Agricultural Engineering, Vol. 9, No. 3. The Journal of Engineering Education, pg. 309. November 1928.

[6]Unpublished reports of the College Division, American Society of Agricultural Engineers.

Agricultural Engineering Extension

By B. B. Robb[1]

EXTENSION work in agricultural engineering had its beginning in the days of the farmers' institutes, when agronomists and representative farmers discussed irrigation, drainage and farm machinery in connection with soils improvement and tillage. These discussions provoked inquiries which involved so-called "follow-up" work.

Well do I remember going out on this follow-up work. The general procedure was to write to the farmers in question advising them the date it was possible to visit their farms and the time of arrival at the railroad station. On arriving at the station the first problem was to locate the first man. Telephones were not so numerous then, and this job which is so simple now might take two or three hours. Finally he came with his farm team and democrat wagon, and you started off, probably holding an umbrella to protect yourself and some of him from the spring rain. If two or more farmers were to be seen within the radius of a few miles, one farmer might take you to the next farm or you might go to the livery stable, rent a horse and buggy, and drive to the respective farms.

These early jobs in the East were usually to assist in laying out a drainage system, in getting a water supply system for the farm, or possibly to give advice on the construction of some farm building. These trips gave the embryo agricultural engineer an opportunity to study actual conditions existing on farms. They also gave him food for thought as to how he could best fit into the agricultural picture.

The early efforts of many agricultural extension workers were not universally appreciated, and there was much talk about "book farming" and "white-collar farmers." Those who started by doing follow-up work and giving individual assistance on engineering subjects, were fairly free from this sort of criticism, as they had to do with subjects of a direct and practical nature.

With the introduction of the early departments of farm mechanics into our colleges of agriculture, workers in this field took some part in farmers' institutes, the then prevailing popular method of extending agricultural information. The appearance of gas engines on farms marked the beginning of a new era in agriculture. It not only gave the farmer a new, convenient and cheap source of power, but it brought him face to face with a brand new problem, namely, the care and operation of a machine more complicated than anything with which he had hitherto come in contact. He now had delicate bearings, close workmanship and even electricity to deal with.

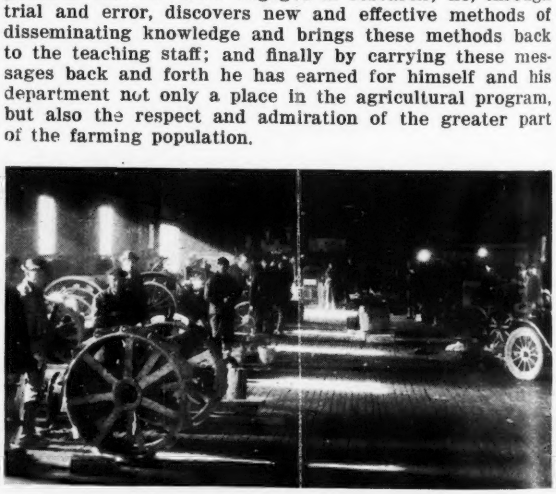
About this time agricultural extension schools became the popular method of disseminating agricultural information and "farm mechanics" readily found a place in this program. With the development of this new agriculture, or the age of machinery, departments of agricultural engineering were developed and a great number of young men began to study the application of engineering methods to agriculture. New machines, new equipment and new methods were devised. Extension agricultural engineers were developed to translate this new material into popular language and carry it out into the rural communities.

When the World War broke out the federal government found a corps of trained men able and ready to give valuable assistance in speeding up the introduction of the new power farming both at home and abroad. During the war the county agent movement was perfected to a point such that there was an agricultural agent in practically every agricultural county in the country.

At the present time, in contrast to the hit-and-miss method of doing extension work referred to at the beginning of this article, the work is carried on through this well-organized machine, the county agent system. The agricultural engineering project leader keeps the county agents informed as to just what comprises the agricultural engineering program each year. The project leader and the county agent through the "Farm Bureau News," and by other publicity methods, give to the farmers information as to the subject matter which is available through schools, demonstrations and other types of meetings. At a meeting of the county agent and the community leaders the general agricultural program for the year is discussed and laid out. Following this meeting the county agent sends his requests to the college for the help of the specialists which he desires. Of course, additions are made to these requests throughout the year.

The land reclamation specialist conducts method demonstrations on subjects such as drainage, irrigation and soil erosion. The structures man puts on demonstrations in barn rearrangement and ventilation, and in other ways assists the farmers with their farm building problems. The machinery specialist conducts gas engine, tractor and farm implement schools, field demonstrations, plowing contests, shop schools, etc. These specialists, besides attending demonstrations, extension schools and other forms of meetings, get out press articles and radio speeches, and in other ways give out agricultural-engineering information. Several states have gone so far as to carry their agricultural engineering work through the home bureaus into the homes. At least one state, through the 4-H club agents, has taken its engineering work directly to the farm boys in order to induce the younger generation to take a more active interest in farm life by teaching them various mechanical skills which are always of value on the farm. The lessons offered are such that they will be of value to the boy now and will form a background and a stimulus for further study, thus tending to establish higher standards of living. Recently there has been proposed, and several specialists are actually putting into effect, the "Hochbaum formula" or the campaign method of putting across a particular piece of engineering work.

In addition to the service rendered directly to the rural folk, the presence of the extension specialist in a college department of agricultural engineering acts as a balance wheel on the department as a whole. He is constantly mingling with the farmers themselves; he learns first hand of their actual needs and brings these new problems back to those engaged in research; he, through trial and error, discovers new and effective methods of disseminating knowledge and brings these methods back to the teaching staff; and finally by carrying these messages back and forth he has earned for himself and his department not only a place in the agricultural program, but also the respect and admiration of the greater part of the farming population.



An agricultural engineering extension school in tractor repairing

[1]Professor of agricultural engineering, Cornell University. Mem. A.S.A.E.

Agricultural Engineering in the Federal Department of Agriculture

By S. H. McCrory[1]

AGRICULTURAL engineering, in the U. S. Department of Agriculture, may be said to be 33 years old. For it was on July 1, 1898, that the first appropriation ($10,000) made by Congress for "irrigation information" became available. Irrigation work had not proceeded long before it was realized that the matter of drainage was involved with it. Thus it was that the first drainage studies were directed toward the restoration of land damaged by irrigation through seepage and the rise of ground water. In 1902 drainage studies were extended into the humid section.

Not until 1915 was Congress sufficiently impressed with the importance of farm machinery and farm structures, as subjects for study, as to assign a definite sum ($15,000) for that work. For several years prior to 1915, however, certain members of the staff of the then Office of Farm Management had done work in these fields and a number of reports and bulletins had been published.

The irrigation work had originally been allocated to the Office of Experiment Stations, and in 1904, in recognition of the importance of the subject of drainage, the name of the unit became "irrigation and drainage investigations." In 1909 these two branches were made separate adminstrative units with separate appropriations, still functioning under the Office of Experiment Stations. This organization continued until 1915 when, as a means of consolidating the engineering work in the Department, the Office of Public Roads and Rural Engineering was set up, which took in not only the highway work, but also the irrigation investigations and drainage investigations from the Office of Experiment Stations, and the socalled rural engineering activities—farm machinery and farm structures—from the Office of Farm Management. All three agricultural engineering units, however, continued until 1920 to function separately, with separate appropriations. In 1919 the Office of Public Roads and Rural Engineering was rechristened the "Bureau of Public Roads," and all agricultural engineering subjects were placed under one administrative supervision, but continued to receive separate appropriations. In 1925 the irrigation and drainage appropriations were combined, and in the following year machinery and structures were added, to form the present Division of Agricultural Engineering with one lump sum appropriation.

The author "grew up" with the drainage activities of the Department, and prior to 1920 had no official connection with the other subjects. In reviewing 25 years of this active participation and casual contact, the two outstanding contributions in the fields of irrigation and drainage seem to be the accumulation of data respecting the duty of water in irrigation, and what may be called the hydraulics of irrigation and drainage. The duty-of-water studies have been carried on continuously since the inception of irrigation work in 1898, and a large mass of this extremely useful information, applicable to the entire arid West, has been made available in publications. For this excellent piece of work we are indebted chiefly to Dr. Samuel Fortier (Honorary Member A.S.A.E.), whose long and unique service to the irrigation farmer has earned him a permanent place in the annals of Western agriculture.

The studies in hydraulics, including run-off, and flow in irrigation and drainage channels and conduits, although begun later have covered a very wide range of conditions and the aggregate results constitute a valuable contribution to the knowledge of these subjects.

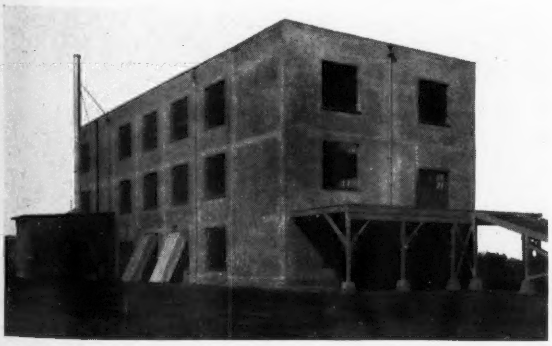
Prior to 1920, direct engineering service to the farmer absorbed a large part of the funds allotted to drainage work. This involved hundreds of instrumental surveys, ranging in scope from individual fields, for tile, to proposed drainage and flood control projects covering several counties. With the increased development of the state agricultural extension services, and the advent of practicing engineers skilled in large-scale drainage and irrigation work, the policy of rendering aid of this type has largely been discontinued, and major attention is now given to research.

From the start, and up until about six years ago, only meager research work in the fields of machinery and structures was permitted by the funds available. A number of bulletins had been put out, however, and gradually a limited structures plan service was established. Mail inquiries in these fields have always been heavy and have absorbed much of the time of the personnel. With the advent, in 1926, of the lump-sum appropriation for all agricultural engineering work, it became possible to expand somewhat the work in machinery and structures research. The outstanding mechanical activities have been the work in connection with European corn-borer control, and Davidson's and Walker's surveys of the mechanical farm equipment research field. The somewhat similar treatment of the structures research field, by Giese, gives much promise for the future of this hitherto neglected, though vital, subject. The advisory councils in these respective fields, set up by the Secretary of Agriculture, have been of inestimable value in dealing with these projects.

In an effort to effect a liaison between state and federal extension in agricultural engineering, the Division of Agricultural Engineering has for the last few years maintained jointly with the federal extension service an engineer who gives his time to perfecting these relations.

What of the future? The logical subject-matter subdivision of agricultural engineering is now pretty well established. The new Bureau of Agricultural Engineering will be organized in general on the usual basis; namely, machinery and power, structures, irrigation, and drainage, having in mind certain further subdivisions as funds become available for expansion. For example, it is felt that there is a field for a unit dealing with what may be termed briefly the engineering-economic phases of land development. A rural-electrification unit may also become warranted. Soil-erosion control is expected to develop to a point where it will become the subject of a major unit.

[1]Chief, division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture. Mem. A.S.A.E.



The new U.S.D.A. cotton ginning laboratory at Stoneville, Miss.

There will probably develop a necessity for expanding our cooperative relations with the federal extension service to the point of dealing separately with each of the major subject-matter subdivisions. Emergency problems—of which the European corn borer invasion and the cotton ginning difficulties are typical—undoubtedly will continue to arise and require diversion of funds from the established program. In the last few years the rendering of engineering service to other bureaus of the Department of Agriculture, as well as to other departments, has assumed such proportions as to justify the segregation of this work.

Space here available permits no more than a mere enumeration of some of these prospects. The field is almost unlimited, but it can be covered only so far and so fast as means became available.

Agriculture's Engineering Department

By H. W. Riley[1]

THE advent of the machine age in industry brought with it a similar development in agriculture. The metal plow and mechanical seeding and harvesting devices were contributing causes and resulting developments of the rapid opening of the farm lands of the Middle West. As in many other developments, the early inventions were made by men engaged in the activity that the invention was to serve. Cyrus Hall McCormick was a farmer.

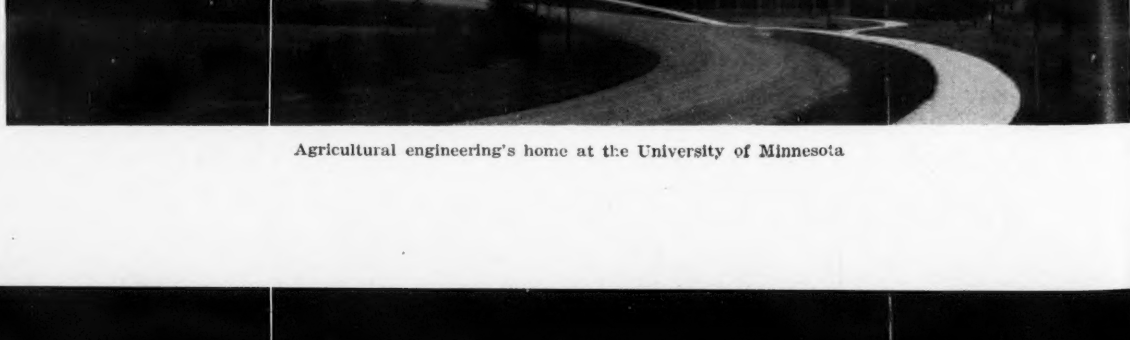
A similar situation has existed in other engineering activities; engineering for irrigation systems was first done by farmers to meet their farming needs; highway building was first done by soldiers for moving armies. When civilians began to displace officers as engineers, the profession of civil engineering came into being to do the type of work which was at one time the exclusive activity of military engineers. Mechanical engineering, as such, came into being only after the native ingenuity of man had developed a considerable activity in the building of machines. The pioneers in electrical engineering by their work earned for their profession a separate designation. In an entirely similar way agricultural engineering has gradually earned a designation separate from other engineering, just as the specialists in automotive equipment have subsequently split off and become separate from the parent profession.

Agricultural engineering, as it is today, may be defined as the application of civil, mechanical, electrical and sanitary engineering and architecture to the problems of agriculture. This special grouping of parts of all these other special group activities has come about naturally, because the needs of agriculture are extremely varied and at the same time very special.

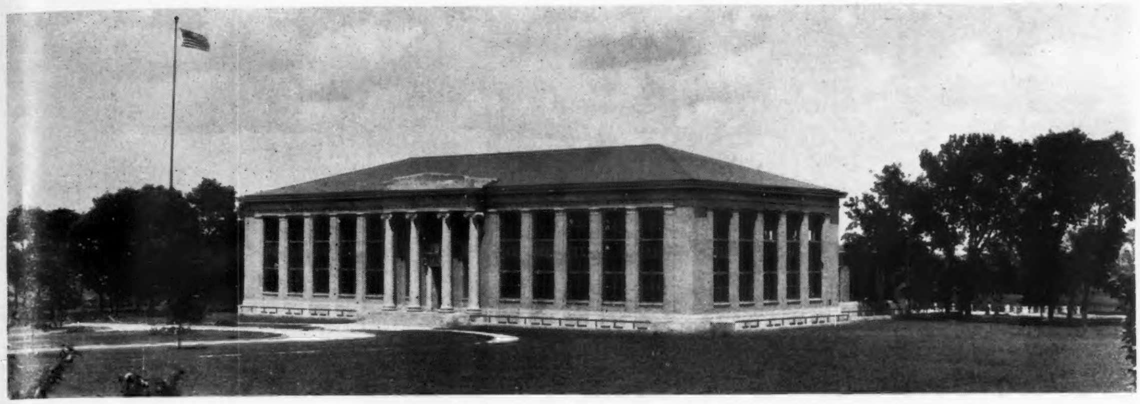
The farm is an extensive factory whose floor and working medium is the soil with varying character, condition and contour; the heating and ventilating system is the local climate with its wide variations in moisture, air movement, temperature and sunshine; the products of the farm are all of biological origin and development, and so subject to wide variations in growth and decay that require special knowledge and skill in caring for them. The facilities that the farm home should provide are determined by the activities of the life of the farm, and on most farms these call for a dwelling quite different in certain details from the village or city home. The framing of several good types of farm barns was not developed by theory on a drawing board, but was the product of years of development in practical barn building by generations of men who were quite untrained academically, but who steadily advanced their designs beyond the achievements of their brother builders, the successive advances having been proved in the great out-of-doors laboratory of wind and weather to be dependable and safe. Other untrained men have ventured and failed, and their failures have served to point the need for help from the trained agricultural engineer who would unite theory with the achievements of empirical practice and so produce a structure better than either could provide alone.

As the development of farm machinery was the dominant factor in bringing about the emergence of the agricultural engineer from among his brothers, it is quite logical that the date of the beginning of agricultural engineering as a profession should coincide with the completion of the first stage of development of modern farming implements. The last half of the nineteenth century was the period of development, and the dawn of the twentieth century brought with it the inception of this new profession. As the field is so varied and many of the problems involved very technical, as well as special, it is quite logical that the new activity was recognized as such first in the land-grant colleges where all the varied interests were united more than anywhere else in the country. It is logical, also, that the place of first development should have been where the new machinery played the most important part. The east and the west were not slow in following the lead of the north central states, and the early

[1]Professor of agricultural engineering, New York State College of Agriculture. Charter Mem. A.S.A.E.



Agricultural engineering's home at the University of Minnesota



A close-up of the agricultural engineering building at the University of Nebraska

organization of the American Society of Agricultural Engineers provided the much needed rallying ground to bring together commercial engineers with farming interests, as well as those compactly held within the land-grant colleges and the U. S. Department of Agriculture. The recent development of rural electrification and of automotive engineering with the automobile, the truck, and the tractor with power take-off, have very largely increased the importance of this whole activity.

The departments of agricultural engineering in the land-grant colleges are very logical results then of this whole transition. The factors affecting their development have been many, but they probably can be all summed up under the two headings: personality and environment. The personalities of the men selected to head the department; the personalities of the men they selected to assist them; the personalities of the legislators, the presidents, the deans, the trustees, and the faculties that ruled upon the plans advanced—these have all varied and have affected the results. Every college exists in an environment of its own, the problems of its farmers and their relation and attitude to the college are all different and their powerful influence is pictured in the departments. In some states, all the phases of the work are under one head; in others, it is divided. In one state it has generous support, while in another it languishes for lack of funds; in every state, however, the individual men have worked hard, the field has been new and almost untouched, and fine progress has been made.

In the teaching field, subject matter and teaching methods of the older engineering schools and physics departments have been overhauled, expurgated and adapted for use with agricultural students, and new vocational material has been organized and given in a manner best suited to the agricultural need and point of view. Courses for students majoring in crop or animal subjects are known as "service" courses and are quite distinct in grade and method from the work given to students in the courses leading to a professional degree in agricultural engineering. Courses for women students are being given and are being increasingly appreciated because engineering is coming more and more to be part of the home. Much remains to be done but great progress has been made and the future is bright.

In extension work the college department has been a most important factor. Through the usual channels of bulletins, meetings, schools, farm visits, lectures and radio addresses, there have been carried to the people the messages that engineering has to give toward improving home conditions, rendering more efficient the vitally important field machinery and implements, revising field processes to keep in line with engineering progress, reclaiming and conserving the soil itself, planning or replanning the farmstead layout and the buildings themselves to save in labor or to meet the needs of changing requirements in the handling of the products of the farm, especially as regards fluid or market milk and cream.

In research work there are several main types of problems that logically come within the field of the college investigator: those of importance to agricultural progress but in which no commercial concerns can see financial return to warrant them in undertaking the work, as in homemade barn ventilating systems; those of such a nature that an impartial opinion is essential, as in tractor testing; those in which a long and varied program must be carried through, as in making paper from cornstalks; or those involving fundamental research as to the basic relationships involved, as investigations in soil dynamics to show the way in the vast problem of the design of tillage implements. These problems and scores of others are yielding to the study and effort of university engineers.

Much that has been said about the development of agricultural engineering in the land-grant colleges applies with equal directness to the development in the federal department of agriculture. Having an early emphasis on land drainage and reclamation the work has gradually broadened in its scope until now the federal engineers include in their activities all phases of agricultural engineering as applied in all sections of our great country, a fact that has been fittingly recognized by the recent formation of the Bureau of Agricultural Engineering, which will continue in an even bigger way the fine work that has been done for so long by the division in the Bureau of Public Roads.

An article with this heading would be glaringly incomplete if it did not give full credit to the very able engineers of the commercial industries supplying the needs of agriculture, whose work in developing the new machines was the most directly stimulating cause of the emergence of this new profession into a separate group. Their inventive genius, manufacturing skill and aggressive salesmanship have given the American farmer his modern equipment and made the situation that has brought into being the state and federal departments.

Just as Cyrus Hall McCormick, the farmer, was a mighty factor in the development of the modern agriculture, so many other farmers of our present day are contributing their bit by new ideas and new devices to make more perfect and complete the engineering equipment of the farm and of the home of the present-day farmer.

And so we find that agriculture's "engineering department" is made up of a great army of able men in federal and state employ, commercial and private life, all of whom are making their special contributions to agriculture's progress. Above all these activities stands the American Society of Agricultural Engineers, with its effective technical organ, AGRICULTURAL ENGINEERING, uniting and coordinating all workers for greater effectiveness in that industry that supplies the basic needs of man.

Engineering-Economic Relationships in the Agricultural Industries

By Arthur Huntington[1]

THE engineer has been an important factor in building our present economic structure. Much of our unbalanced economic condition has been caused by his handiwork. The time has arrived when he must assume some of the responsibility of creating a mass buying power comparable with our ability to produce. Our present economic disturbances are the result of the failure of business to accept and distribute the benefits of production.

For about a century by a better use of power and equipment, the occidental nations in general, and America in particular, have enormously increased the supply of raw material. By the use of mechanical power and equipment these same nations have enormously increased their ability to process this raw material into finished product. These increases have been all out of proportion to the increase in population, notwithstanding the fact that an ever-decreasing number of workers has been employed in the producing and processing of basic commodities.

During this same period methods of distributing the products and the apportioning of the benefits of production have not kept pace. We have failed to create business practices which are able to balance our ability to produce. It must be admitted that we have greatly enlarged our trade territories, we have absorbed released workers, we have made the wheels of business turn faster, but by and large we have simply made the wagon of business carry a larger load and run at a greater speed, until in 1930 collapse came, and in 1931 we find ourselves in the midst of a readjustment period.

How shall we adjust? How can we meet our present economic crisis? There are two ways. We can curtail our ability to produce wealth until our business machinery will stand up under the burdens placed upon it, or we can revamp our business practices so that we can properly distribute the benefits of our ability to create wealth—in other words, more efficiently provide the people with a fair supply of those things which stand for a higher standard of living.

Stated more concisely, shall we adjust ourselves to a lower standard of living, or is civilization going to take a step forward? Shall we entrust our economic future to business practices which have already collapsed under the strain of inadequacy, or shall we strive to reorganize our trade channels until they are capable of handling the output of our production machinery?

Too long has the engineer been content to produce without concerning himself with the disposition of his products. Too long has he thought in terms of what can be made to happen in production, and relied on men who by training and instinct cling to obsolete practices, which have been established by custom, for distribution.

For generations the great economic problem was the production of a quantity sufficient to maintain existence. The engineer rendered much service in meeting this problem and more; his efforts have contributed to an improvement in quality and to decrease in cost, until both producers and consumers have been benefitted.

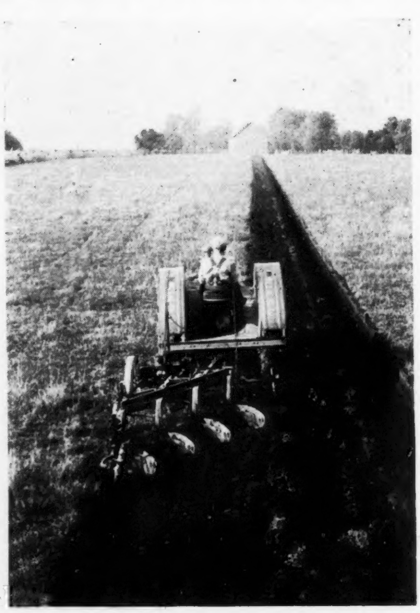
Late in the eighteenth century the engineer came into industry with the steam engine, and speeded up production until there was created what has come to be known as the "industrial revolution." The machine age of agriculture starting about 1850 produced similar conditions.

The time has arrived when the engineer must interest himself in the economics of both industry and agriculture. He must help to solve the problem which he has been such a large factor in creating. He must become a factor in analyzing each industry. But he must do more; he must help to coordinate the various industries to the end that we may know how the disturbances in one industry will affect other industries.

He must help correlate price and cost, wages and purchasing power, and many other things, until there is a better balance between production and consumption. He must exert some supervision over reestablishing into other industries those workers who have been replaced by machines.

For 150 years there was no effort made to extend the benefits of the machinery which produced the industrial revolution. What benefits the workers did receive they had to fight for. In self-defense, those who could were forced into guilds whose object it was to retard the wheels of progress, so that hand-power methods could compete while the rest were left to eke out a miserable existence in the attics and basements of the cities which became industrial.

Mechanical agriculture is following too closely the path which industry trod. Too much faith is being placed in those methods which contemplate economic readjustment which will conform to business practices which in the past have failed, and not enough time and effort are being expended in trying to coordinate consumption with production.



Engineering is solving the production problem. What about consumption?

Too much effort is being made to readjust on the basis of the ability of the inefficient to produce, and not enough thought is being given to the creation of conditions whereby needy people can secure those things which we now have in abundance with idle men and equipment waiting to produce more.

In the midst of hungry people we are talking surplus.

The engineer and the product of his brain has made our surpluses possible. But why say "surplus" when with sufficient buying power our own people can consume without extravagance all that our farms can produce and our factories can process.

America is suffering from an economics based on theory rather than one based upon the supporting data of basic facts.

The time is now here when the agricultural engineer, I might say all engineers, must rise to the oc-

[1]Public relations engineer, Iowa Railway and Light Corporation. Mem. A.S.A.E.

casion and exert a leadership in the apportioning of the benefits of production, comparable with the leadership he has in the past and is now exerting in the field of producing raw material and the processing of it into usable products.

The time is ripe for the man, who created the machinery of production, to be called upon to analyze the situation and to devote his talents to devising ways and means whereby the body politic can receive a maximum of benefits from our ability to produce. The agricultural engineer is crowding his way into a place of leadership.

Mechanical Power — The Basis of the Next Agricultural Revolution

By L. J. Fletcher[1]

President-Elect, American Society of Agricultural Engineers

MECHANICAL power has not yet revolutionized the industry of agriculture, but it will be the principal cause of the next great radical change in this ancient industry. Agriculture has successfully survived previous revolutions and undoubtedly will undergo many more in years to come.

Agriculture is old and rather set in her ways. She resists change. Compared with other industries, her habits are much more difficult to alter. Scratch the surface of this great industry and out pop literally thousands of subindustries—all near relatives, but differing as to soil type, temperature, rainfall, contour and crop characteristics. Each one of these must be patiently cornered and its mechanization pattern prepared. And then, even though it is recognized that real development and progress of any mechanism comes mainly through extended use, the new agricultural machine is barely across the threshold of its nursery before it is pounced upon by critics who compare it pitilessly with the existing order.

Lack of confidence in the ultimate success of the mechanization program, on the part of so many connected with agriculture, is the greatest single handicap to real progress in this field. For example, it has been the style to compare the cost of work done, per unit of area, by tractors and horses, assuming that any power, which will be able to replace another, must do the work cheaper. The dependability and versatility of the tractor have materially improved since its early years, and it is now successfully competing on an area-cost basis with other forms of field power. However, recent studies[2] of farm profits indicates that these profits result more from high yield and quality than from low expense per acre. A tractor, through its greater capacity for accomplishing work, enables the farm operator to till, plant or harvest at more nearly the right time. The reported results of many experiments clearly prove that this timeliness of operation is directly responsible for increased yields and quality, and, therefore, lower costs per bushel or pound.

[1]Agricultural engineer, general supervisor of agricultural sales, Caterpillar Tractor Company. Mem. A.S.A.E.

[2]"Organizing the Corn-Belt Farm for Profitable Production." University of Illinois Bulletin No. 329 (page 274).

Electrical energy is now being applied to an increasing number of farm jobs. Through its light, heat and power it is bringing a new meaning to farm life. Well-directed research in farm electrification is producing valuable results. New discoveries in the field of electric power may change the course of the entire farm power program.

Mechanical farm power must successfully pass through three stages, however, before it can become the cause of the next great agricultural revolution:

1. The first step is logically the development of the motive-power unit itself. It is this phase that has received the first attention of those engaged in the application of mechanical power to agriculture. Much has been accomplished in this field; in fact, most of this work is behind us. Mechanical power is versatile. There is a wide choice of ground speeds; energy may be applied to machines through draft or rotating shafts, or it may be translated through moving liquids or air. Thus new possibilities arise; new ways of accomplishing the desired results are uncovered.

2. The second phase is the designing and building of suitable equipment to be used with this new power. It is evident that a farmer has no use for only a tractor; suitable machines and implements must be provided through which this mechanical energy may be utilized. Until the farmer can buy "jobs done" in a way that will reduce human toil or yield greater profits, he cannot make radical changes in his farming program. There is still to be defined the real agricultural requirements that many of these new machines must meet. While this is especially true in the field of soil manipulation or tillage, new facts are being established concerning planting methods, the correct handling of fertilizing materials, care of the growing crop, and the like. While it would seem that the requirements for harvesting machines would be quite definite, a new variable is introduced here in the way of possibilities of changing the characteristics of the plants themselves so as to make practical new methods of harvest. Yet, in spite of the frequent lack of a definite goal for the designer of power-operated equipment, tremendous strides are being made; in fact, this phase is now receiving the major attention in the farm mechanization program.

(Left) Pulling and binding flax with a power take-off operated machine. (Right) Following the straw-trail of a combine with a combination pick-up and baler. To many farmers straw is an important by-product of the grain crop

3. The third phase is that of trained management. The user must learn to know and to employ effectively this new equipment. We are just entering this phase. Even efficient machinery cannot succeed in the hand of men unacquainted with its possibilities and often lacking confidence in its ability to better meet their needs. The manager of this new equipment will have to learn the correct **size** of the farm project for maximum profits. Having more control of time, he will have to learn **when** jobs should best be done; having a wider range of choice as to **how** work may be done, he must again decide what is best for his soil, his contours, his climate and his crops. For example, in tillage he is each year allowed to choose from a wider range of soil-working equipment. And this new manager may do that which is, as yet, seldom done; he may actually change an existing practice or habit of this ancient industry to allow himself to realize more fully the profit-making characteristics of his new equipment. Row spacings may be altered to meet a desirable standard; soil may be moved to the right rather than to the left; a dollar in return may be sacrificed to save three dollars in expense. Power machinery — well managed — will take its rightful place with the other essentials—land and buildings—and be considered an investment rather than an expense, even in the eyes of the banker.

At the completion, therefore, of these three steps in the farm mechanization program, we will then be in a position to really embark on a new agriculture, an agriculture allowing those engaged in its ranks a larger opportunity to use their skill and training, to produce quality products at lower costs, and to provide a healthful and happy life for those engaged in its every activity. The change to this new agriculture will be so gradual that it more correctly should be termed an "evolution" rather than a "revolution."

It is not difficult to foretell this development, because in every industry there are the pioneers who show the way. These are the men who have confidence in the success of this new idea. They accepted the tractor, first, in its undeveloped stage, and now in its more nearly perfected form. They have adapted the old machinery, and they have designed and built, or utilized, the new. They are blazing the trails for the farm managers of the future. They have taken each step much as a man crossing a range of mountains, seeing only the peak immediately ahead, but not giving up when, after reaching that peak, they see another one beyond—higher, more difficult to ascend. They progress through solving the problems of today which have arisen out of the solutions of their problems of yesterday. To these pioneers, whether they be on the farms, in the colleges, or in the factories of America, we will look for guidance so as to make this next "revolution" in agriculture a happy and profiable one.

Tomorrow's Jobs for Agricultural Engineers

By Wheeler McMillen[1]

TOMORROW'S work for the agricultural engineer is to do more of what he did yesterday and is doing today.

The engineer in agriculture has been essentially a cutter of costs and a promoter of efficiency. The outlook for the farming industry invites—demands—more wide-spread lowering of costs and a general increase of efficiency.

The agricultural engineer can confront the future with one definite satisfaction: He can be sure the big things have not all been done. The quarter century behind us has seen amazing progress—but progress that has been accompanied by such multiplication of new problems that some wonder whether it has been forward or backwards. The years ahead are certain to require even greater achievements, less spectacular, perhaps, but accomplishments of even more definite importance.

The engineering world has momentarily found itself amazed to be charged with evil works, with having shared heavily in complicity for throwing the economic world out of balance. When the engineering tongue is rescued from the cat, it will find devastating replies to make. Foremost, surely, will be the answer that adjustment will be attained not by less engineering efficiency, but by more of it.

For instance, let any critic of the engineer's contributions to efficiency in production take one searching look into the stunning disproportion between the cost of growing or manufacturing an article and the cost of placing the commodity in the ultimate consumer's hands. He may wonder if a little of the engineering approach might not aid distribution. That may be one of tomorrow's tasks.

The production job is not finished, by any means. Foremost of the immediate tasks facing the power and machinery engineer is to make further available to the small farmer economies comparable to those now preserving earning power for the large-scale operator.

This is important. Despite the superior advantages of large-scale operation under skillful management, capital is so ditheringly timid before every proposition to finance agricultural production that years will elapse before the size of farms will grow up to the size of farm machines.

Greater economies in small-scale production must in the meantime be sought. Equipment that first appeared in large units is already being scaled down. This should be good business, since in the United States are 207,000 farms of over 500 acres as against 3,747,000 of between 50 and 500 acres.

The multi-purpose tractor's popularity suggests that it may not be beyond the capacity of farm machine designers to go further with other many-purpose machines, such as a combination grain drill and corn-bean planter, or a combination plow and soil fitter, that will reduce the small farmer's equipment overhead and increase his effectiveness.

Likewise the farm structural engineers may find new short-cuts in materials and methods that will lower building and maintenance costs. Rural electrification in spite of intensive and able endeavors, remains largely the adaptation to farmsteads of urban electrical uses. Awaiting some bold mind is the opportunity to put something in this field that will be distinctly agricultural electrification.

We may see in our times a race between electrical and fuel experts for the biggest power contract in the United States. Neither group has yet done its best. The internal-combustion engine is only tolerably efficient in its utilization of available power, and who knows that there are not other fuels to develop than the still too costly ones now in use? And certainly greater marvels have become commonplace of late than the use of electricity for mobile field power would be.

These are but hints of what may transpire, based on needs that we perceive today. Tomorrow will bring more new problems. One may hope that the agricultural engineer who meets them will be accorded more encouraging recognition than in the past.

Anent tomorrow's jobs, perhaps there is some significance in the fact that our ablest leaders amongst agricultural engineers today have, almost without exception, a dash of the economist in them. Consciously or not, they are aware that an engineer deals not alone with men and materials, but with the intangible habits and reactions of mankind. Their service has been greatest because they have been able to see furthest into the future. Men of their type see tomorrow's jobs coming, and are prepared.

[1]Associate editor, "The Country Home." Aff. Mem. A.S.A.E.

The Machine Age in American Agriculture

By F. A. Wirt[1]

IN EUROPE, at the time of the outbreak of the Revolutionary War, food was a problem, for nations were becoming crowded. Up to that time the world—even the more civilized countries—had never enjoyed enough to eat. War, pestilence and famine were the three sinister specters constantly facing the nations of Europe and other continents. The pressure for food was becoming so great that inventors were already busily engaged in developing mechanical methods to increase individual output.

The farmers of the thirteen colonies along the Atlantic coast naturally began with farming methods very similar to those they had known in Europe. They used practically the same implements and tools. That was still true in 1775.

The soil was prepared slowly and laboriously with a metal-faced wooden plow. A crude wooden contraption made at home served as a harrow. By beginning earlier than desirable and finishing too late for best results, the seedbed could be prepared and then sown by hand as the sower plodded up and down the field.

But the worst was yet to come. Harvesting with a scythe, later with a cradle, the man cutting grain shuffled along hour after hour, the hot sun falling blistering hot on neck and shoulders. With excessive slowness contrasted with today, the grain was cut, tied into small bundles by hand, and shocked.

By beating with a flail or by driving animals over a threshing floor, the grain was removed from the head. Then followed winnowing and feeble efforts to clean grain from the chaff and dirt. Not much grain at a time was made available for human consumption. Seven bushels of wheat or 18 bushels of oats could be laboriously threshed with a flail in a day. Sometimes horses were used to trample out the grain. Threshing, a long, tedious job, was an all winter's task. (Today, a few men with a modern, fully equipped 28x46 thresher can easily thresh and clean 100 bushels per hour.)

The farmers of the Revolutionary War period were using methods and equipment not much if any better than those of the Biblical days of Abraham and Joseph. Virtually no progress had been made in agricultural production for century upon century.

With vast areas to settle, a scanty supply of labor and hunger for food three times a day, conditions were distinctly favorable in America to the rapid development and application of more pretentious implements and machines with which an individual could accomplish measurable results. Many farmers, blacksmiths and others were busily engaged in developing new machines. With hardly an exception, several men would be working on the same type of implement, or idea, differing only in details.

The following represent the outstanding developments in farm machinery during the period of 1775 to 1850:

[1]Advertising manager, J. I. Case Company. Mem. A.S.A.E.

1. In 1793 the cotton gin was invented by Eli Whitney, so cotton growing took a great spurt in America
2. In 1797 Charles Newbold made the first cast iron plow, but it was a failure—not because it wouldn't work, but because farmers believed such a plow would poison the soil and encourage the growth of weeds
3. In 1831 the Manny mower was patented, it being the first successful machine of its kind
4. In 1831-34 Hussey and McCormick separately invented, patented and made successful grain reapers
5. In 1834 the endless-apron type of thresher was invented by the Pitts brothers
6. In 1836 Moore and Hascall of Michigan patented a combine, which possessed many elements of success
7. In 1837 the first commercially successful steel plow was made by Andrus and Deere at Grand Detour, Illinois.
8. In 1842 J. I. Case established his thresher business and, as years went by, improved thresher design.

The above are only a few of the stream of patents taken out on farm machinery from the time the United States Patent Office was opened. But between the time of development of a reasonably satisfactory machine and its widespread adoption, many years—ten, twenty, thirty, or even more—usually elapsed.

The shift from hand to machine methods, marking the beginning of the first great agricultural revolution in the world's history, culminated in 1850. Rev. John L. Blake, in his "Farmers' Every Day Book" printed in 1851, mentions only "the plough, harrow, hoe rake, fork, wagon, cart and the like." He devoted a chapter to proving that oxen were better than horses for farm power. A farm machinery census was taken for the first time by the federal government in 1850, in which machines to the value of $6,843,000 were produced, as compared with $609,063,605 in 1929.

The stream of improvements and new designs became larger with the shift from hand to machine methods. Among those coming during the early part of the period of 1850-1925 are the force-feed grain drill (1851), the first straddle-row two-horse cultivator (1856), the wagon-type manure spreader (1865), the wire binder giving way to the binder with twine knotter, and the portable steam engine for belt power use (1870). In general this 75-year period saw a shift from walking to riding, and from one to two-row machines. During the last 25 years of this period, tractors and special tractor equipment came into use, bringing about the second agricultural revolution, in which we find ourselves today.

During this second 75-year period a great migration from the farm to the city took place in America, a movement which made possible the rapid development of industry and resulted in the greatest industrial progress of all time.

The alternative of the application of engineering to agriculture—women laboring in the fields, long hours, slow progress, for a poor existence


Simple means of threshing with low equipment overhead and with operating cost proportional to the value placed on human life, time and comfort. Labor-saving machinery teaches farmers to value their time

Progress in the development and utilization of machine methods was very slow at first. Labor-saving machines were crude in design and construction, but they were so much better than the burdensome hand methods formerly employed that labor-saving farm machinery was rapidly adopted. Advancement and progress, however, met human opposition, as it always has and always will. Many men were shamed into operating grain binders by harvesting demonstrations where the binders were operated by men dressed as women. In some sections grain binders were burned or otherwise destroyed. The development of cast iron plows was postponed for years because of the foolish notion that cast iron would poison the soil.

By 1925 the utilization of improved farm machinery had completely revolutionized farm methods and farm living. From preparation of the seedbed to harvesting the crop, each operation was by machine. There was famine no longer, except in countries still using hand methods.

A presentation of any one of the nine outstanding and far-reaching results of machine methods in agriculture would require the space of an entire issue of AGRICULTURAL ENGINEERING. The following paragraphs, therefore, only briefly outline the amazing results:

1. The physical and mental nature of the farmer has been profoundly improved with the adoption of machine methods, permitting him more leisure for planning, social contacts and participation in community affairs.

2. The working day on the farm has been shortened.

3. Women, the first agriculturists, have been emancipated, first from field work, then from spinning, weaving, candle making, butter and cheese making, and much cooking.

4. Farm wages have been increased, for skilled labor is always better paid than unskilled.

5. Population on the farm has greatly decreased. Ninety-seven per cent of our population, it is estimated, was on the farm in 1800; 90 per cent in 1850; and today about 22 or 23 per cent, with every indication of this dropping to as low, possibly, as 15 per cent.

6. Increased production per man has resulted from better work more timely and quickly done.

7. Production costs have been decreased, for work can be faster and better done with less labor. The equipment with which the user increases his individual output has a greater influence in reducing costs.

8. Quality of farm products has been greatly improved because of more timely preparation of the seedbed, planting, cultivating and harvesting.

9. A higher standard of living for the farmer and his family has very naturally followed the foregoing advantages of applying machine methods to agriculture. This has made farming and farm life more profitable, more satisfying, and more enjoyable.

The first successful tractor of record was built at Racine, Wisconsin, in 1892.

Tractors were first built in commercial quantities beginning about 1901. Production was small until 1909, when it was estimated 2,000 were manufactured. From that time on, the number increased by leaps and bounds. The year 1913 saw the passing of the large, heavy, cumbersome tractor then in vogue. In its place appeared the two-plow small tractor, much lighter in weight, faster in speed, but underpowered. Since the pendulum had swung from one extreme to the other, further development was in the direction of more highly efficient tractors between the large and the small. By 1920, 246,085 tractors were found on farms of the United States, by 1925 there were 505,933; and by 1930 almost 1,000,000.

While tractors were used by the tens of thousands prior to 1925, it was not until that year that the general-purpose tractor came into its own. With its advent the corn and cotton grower for the first time could fully enjoy the many advantages of power farming.

Tractors other than the general-purpose machines had by 1925 reached a high state of mechanical perfection. Tractor plows, harrows, and other tractor-drawn equipment were greatly improved. Combines had completely changed harvesting methods in the Southwest. The wheatland plow was being used in rapidly increasing numbers in much the same territory to speed up seedbed preparation and reduce production costs.

That farmers themselves recognized both the necessity for and the advantages of power farming is borne out by their attitude toward animal power, for between 1918 and 1930 the horse and mule population decreased nearly 8 million head.

So another dramatic revolution is taking place in American agriculture, following just 75 years after the close of the hand-method period. With the faster speeds and greater areas covered per hour and per man, by the modern, cost-reducing farm equipment, the advantages of machine methods will be multiplied. Agricultural progress will be greater. Farm living, for the efficient, will be decidedly more attractive.

While America has led in the development of machine methods in agriculture, we have failed miserably for several decades to accord it the recognition which it deserves, as a means for making farming a more remunerative and satisfactory business. With the great advantages of machine methods so readily apparent to informed observers, it seems difficult to realize that so much attention has been paid to marketing, to efforts to increase the selling price of farm products, rather than proven machine methods for decreasing production costs and thereby assuring a larger profit. It has been equally difficult to

understand why so many have taken a critical attitude in restraint of more widespread use of efficient farm equipment with which the farmer can best control his costs of production.

This discussion would not be complete without emphasizing again the influence of farm machinery and mechanical farm power upon the farmer's profits. When he decreases his cost of production, he can meet the competition of other farmers, domestic or foreign.

Profit is equal to Selling Price minus Production Costs times Quantity. Selling price cannot be increased by the individual. If increased selling prices are made possible by law, increased production follows—then overproduction, glutted markets, and falling prices. The law is repealed or becomes inoperative. Then after a prolonged chastening period of readjustment and decreased production, supply and demand again more nearly balance, and prices improve. The efficient user, however, through the proper use of farm operating equipment, very substantially increases the quantity he individually produces, and lowers his production costs.

Power and labor represent on an average in this country 60 per cent of the cost of production, and these are the very items which can be influenced most favorably through efficient machine methods. Investigations show that the crop production per worker is proportional to the power used. The value of crops grown is also proportional to horsepower per agricultural worker. Income is proportional to horsepower hours. As man labor requirements go down and power per man increases, monetary returns per individual increase. In other words, the farmers of this country have available the farm machinery and mechanical power with which to influence favorably two out of three factors controlling their profit—production costs and quantity produced per individual. The third factor—selling price—is controlled by the economic law of supply and demand.

Investigation shows that efficient farmers are able to make a satisfactory profit and work under enjoyable conditions because of modern machine methods. As for the inefficient—the man who does without—he too pays for the machine but does not enjoy its many advantages.

As a result of the second agricultural revolution now under way in this country, we may anticipate

1. Lower production costs
2. The business of farming made more profitable
3. Farm life made more attractive
4. Working day becoming shorter
5. Smaller percentage of the population on the farm
6. Quality of farm products improved
7. Marginal farms going back to timber, pasture, etc.
8. Fewer horses and more tractors
9. Size of farms increasing
10. Gap between efficient and inefficient farmers widening
11. Higher standards of farm living.

Farmer's Contributions to Farm Machinery Invention

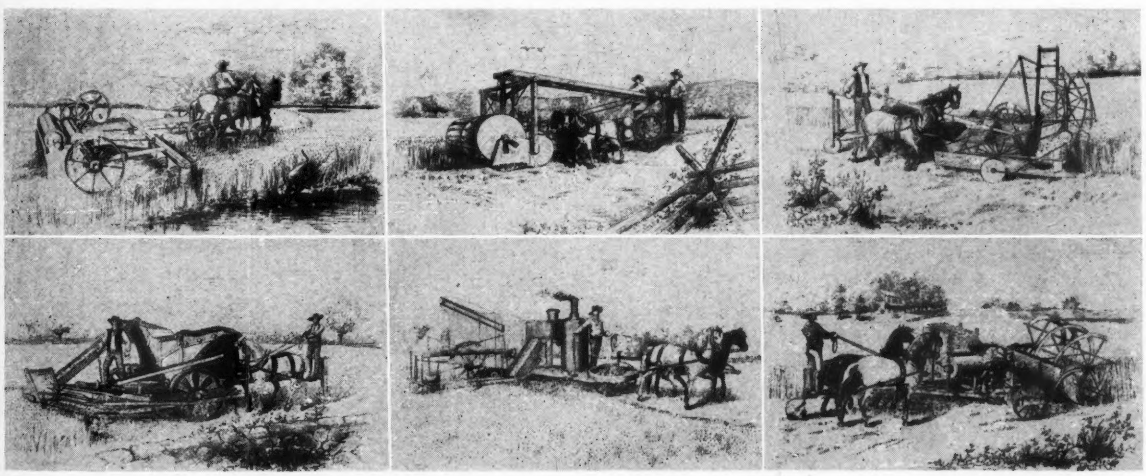
By G. B. Gunlogson[1]

IF OLD Samuel Lane, who invented a combined reaper-thresher back in 1828, could spend a month in Kansas during harvest time, his first reaction would probably be that human life is much too short. He would contemplate upon the part he might have played in the development of the present "combine" if he had lived another hundred years. Samuel might also reflect upon his failure to derive any worldly gain from his invention. Not only had be failed utterly to profit from his efforts, but the attitude of his neighbors in Maine toward this radical and nutty idea probably did not add anything to his prestige or opportunities while on earth. In the matter of human nature, the world hasn't changed much in a hundred years.

However, Samuel Lane was perhaps more fortunate than many of his contemporaries. His name appears in the archives in Washington, while thousand of others, who have contributed in even more important ways to agriculture, are gone from earth without a vestige of identity left behind. What really matters more is the certainty that many others have gotten out with their ideas.

There are two points that I wish to bring out in con-

[1]President, Western Advertising Agency. Mem. A.S.A.E.



A Pictorial History of the Early Development of the "Combine"

1. Combined reaper and thresher patented in U. S. in 1836. 2. Harvester, thresher, separator and sacker patented in U. S. in 1846. 3. Head cutter and side deliverer—U. S. patent of 1849. (Bottom row) 4. Harvester and thresher—U. S. patent of 1877. 5. Steam combine—U. S. patent of 1879. 6. Header harvester-thresher—U. S. patent of 1883

Farmers will continue to invent and to provide ideas for improvements in methods and devices. No one else has the same incentive. More general appreciation of the humble origins of many devices, together with some organized method of encouraging farmers along this line, and of giving their ideas a fair trial, would stimulate engineering progress.

nection with this state of progress. The first is the long time required and the seemingly indirect way for most worthwhile developments, whether they be methods of machines, to mature to a state of general acceptance and use.

This element of time is a factor in the welfare and prosperity of the farmer. If some of our present methods and equipment could have been made available to the farmer two decades ago, would they not have added to his comfort and well-being then, and would not present-day methods have been advanced to a still higher plane? Rheumatism and blisters were just as painful a generation ago as they are now and comfort and conveniences just as welcome. At least, if this conjecture is not sound, then our philosophy of progress is open to questioning.

It is a commonly accepted generality that more progress has taken place in farming operations in the last century than in all the centuries that passed before. But this is no proof that we are now taking advantage of all the meritorious ideas and inventions that are originated. An idea or an invention, regardless of its potentialities, is worthless until it is put across.

The second point I would like to make then is to suggest the need for some agency or organized method for studying and assisting in the exploitation of inventions that appear to offer potential benefits to agriculture.

Anyone who has made a thorough study of the origin of farming methods and machines knows that these have come, almost without an exception, from farmers. Nearly every farm implement we have today, from the plow to the tractor, has been invented and to a considerable extent developed by farmers themselves. For instance, there were a number of small tractors, of crude and improvised construction, of course, made and tried out by farmers some years before the first commercial tractor of this type appeared on the market. This applies also to many details of improvements in machines as well as to basic machines.

Manufacturers have done much to extend the use of mechanical equipment and advance machine methods, but in general it is not their function to exploit an idea or an invention before it reaches a stage of commercial acceptance or value. As a matter of fact, new developments involving changes in operating methods may not always be compatible with the best interests of manufacturers.

When it comes to inventions and ideas for improvements in methods and devices, it is obvious that the farmer must and will continue to supply these. No one else has the same incentive; no one else is burdened with the responsibilities and physical strain of farm work; no one else operates and maintains the machines that are now in use; no one else suffers the loss when machines wear out or delays occur through breakage; and no other men, as a class, in any industry, are called upon to handle more diversified operations or a larger variety of mechanical equipment than the farmer.

What other circumstances could possibly do more to inspire or qualify men to contrive new ways, new devices and new improvements?

Is it not possible that this heritage should be encouraged more by institutions interested in the welfare of agriculture? The individual farmer is more or less isolated. He usually lacks technical training and facilities. He is often faced with local prejudice and adverse influences. He lacks resources and initiative to give an idea the initial impetus which it may require.

The first step would be a more general appreciation on the part of agricultural engineers that nearly all worth while things we have today have come from humble origins. At the outset they have invariably been branded as radical and ridiculous by those who were supposed to know, because these innovations seemed to contradict or conflict with accepted ways of doing things, with accepted standards and prevailing conceptions about the finality of things.

The second step would be, as already referred to, an institution or some organized method which would have for its aim the stimulation of original thinking, of new ideas and their propagation among farmers. It would also provide a sort of laboratory where ideas may be sifted, analyzed and weighed. It would serve to close the time gap between the origin of a worthy idea and its general application. It would aid in its development instead of leaving it to linger in seclusion or pass into uncertain channels of promotion. It would help to protect the interests of the originator if a patentable device is involved. In short, it would serve the technical interests of farmers in a field where there is no adequate service now.

Such an institution, whether an independent body or a committee of some established organizations, would not duplicate, detract from, nor make less important the constructive work in this field, in their respective ways, of educational institutions, the Department of Agriculture, or commercial institutions. As a matter of fact, its important functions would be to coordinate the activities of these agencies in the field of inventions relating to agriculture.

Working with machinery refined by factory production but born of the necessity of farmers

The Nebraska Tractor Tests

By E. E. Brackett[1]

"A BILL for an Act to provide for official tests for gas, gasoline, kerosene, distillate or other liquid-fuel traction engines in the State of Nebraska, and to compel the maintenance of adequate service stations for same." Thus reads the title of House Roll 85, 37th (1919) session of the legislature of Nebraska.

Representative W. F. Crozier, a farmer from Polk County, was the introducer of this measure. He was one of those in his community who had bought the comparatively new type of farm power, and his experiences with two or three different units of his own and his observations of the experiences of his neighbors seem to have convinced him that sales claims were commonly excessive, that many machines were little more than experimental, and that many manufacturers were making no pretense of maintaining stocks of parts or other service. In his opinion conditions could be materially improved and this improvement hastened and made more effective by the enactment of legislation with these objectives.

Probably Mr. Crozier little dreamed of the rapid expansion to come in the use of the tractor, but it is evident that he believed in its possibilities and he introduced his bill with the thought that it would encourage the manufacture and sale of better tractors, and, in a measure, rectify and control certain practices that were detrimental to producer and consumer alike.

The measure became effective as a Nebraska law on July 15, 1919, and delegated the work of testing to the state university. The task was assigned to the Agricultural Engineering Department, and L. W. Chase, O. W. Sjogren and E. E. Brackett comprised the board of three engineers required by the law. C. K. Shedd was selected as engineer-in-charge, and the real job was begun. When the law went into effect these men found their plans only well under way. A building was under construction and testing equipment was being purchased and constructed. Blanks for applications and specifications, details of test procedure, and forms of reports were planned and replanned in this pioneer effort to incorporate the requirements of a law susceptible of varied interpretations into a procedure that would result in reports containing information and data in a form readily understood by owners and prospective purchasers of tractors, and also carrying definite technical value for the designer and manufacturer.

About the time the law became effective representatives of a large number of manufacturers met in Lincoln to discuss the probable effect of this law. Some were of the opinion that there should be united resistance by legal action, but they were in the minority. One phase of the situation which seemed to cause greatest concern was the fear that there would be similar laws enacted in several other states with ensuing confusion and expense. The suggestion was made that any testing program undertaken should be under federal supervision, but this did not receive much support. The board of testing engineers discussed their plans fully and frankly with the group and, in general, the plans seemed to be approved after these representatives realized that the proposed policy of the board recognized the interests of both farmer and manufacturer; that the board was endeavoring to set up a "measuring stick" that would be applied to one and all that would show good points and desirable characteristics as well as reveal shortcomings.

The original law provided that reports of tests "shall be posted in the Agricultural Engineering Department of the State University," and also declared it "unlawful for any tractor company operating in the State of Nebraska to publish extracts from such official tests for advertising purposes, without publishing the entire report." The Board decided that there would be smaller probability of mistakes if copies of all reports were made easily available to all who were interested.

It was late in the fall of 1919 when the first official test was started. This test was interrupted by a snow storm and the tractor was later withdrawn from the test. The first complete official test was conducted between the

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Taking a tractor out on drawbar test

dates March 31 and April 9, 1920, on a Waterloo Boy Model M 12-25 tractor, a two-cylinder, kerosene-burning machine. On October 27, 1920, sixty-five tests had been completed. Three other tractors had appeared for test but had been withdrawn after learning the results of brief preliminary runs; and 35 additional applications were withdrawn before the machines were submitted.

A further detailed study of the records of the first year's work shows ample evidence that a check on advertized claims and specifications was needed. In some cases the manufacturer had no definite knowledge of the power the tractor could develop. He had based his claims on statements and estimates of the makers of the parts he had assembled, without any accurate test of the completed machine. Other organizations seemed to be more interested in selling stock than in building a good tractor.

The procedure followed in carrying out the tests has been revised to some extent from time to time. These revisions include change of length of rated load belt tests, change of length of intervals in the varying load belt test, omission of the half load belt test, change of distance for the maximum drawbar test, and adoption of the single carburetor setting.

The success attained rests with many other persons than those already mentioned. Other names appearing on reports are those of J. W. Haney, C. W. Smith, F. R. Nohavec, J. D. Parsons, F. N. Laub, H. L. Wallace, E. B. Lewis, and C. L. Zink. And credit is also due to the numerous assistants who have shared the routine during the past eleven years. Often have they heard the remark "We never had that happen before" from a manufacturer's representative when some peculiarity of performance developed or some defect appeared. In the early days there were many cases of mysterious disappearance of power between factory and the Lincoln testing plant. The outstanding case of skepticism was that of the manufacturer who was not satisfied until he shipped his own brake testing apparatus to Nebraska to verify results, which checked within a fraction of one per cent. "Hunting for horsepower" has been the favorite sport at the testing plant.

Lest anyone may misinterpret the foregoing, I hasten to add that the attitude of the manufacturers, with very few exceptions, has been all that could be wished. Coming to the test for the first time it was common to find the manufacturer with the idea that this legal requirement was primarily for his annoyance and that particular effort would be made to develop results unfavorable and perhaps unfair to his machine. A few hours on the test usually have been sufficient to correct this viewpoint and disclose the effort being made to treat everyone fairly and alike in procedure and report. With keenest pleasure we have seen machines return to test to show to the world by new and better results that painstaking work of development and improvement had been carried out and that progress had been made.

The number of tests completed each year is as follows: 1920, 65; 1921, 15; 1922, 5; 1923, 12; 1924, 10; 1925, 8; 1926, 12; 1927, 15; 1928, 7; 1929, 16; 1930, 10; total, 175. Nine different circulars and bulletins have been published, totaling over 60,000 copies, and the copies of official reports have reached a similar total.

The thousands of dollars spent in this project may perhaps be justified on the basis of corrective and restraining influence, but all of those directly responsible for the testing have always cherished the idea that the greatest value would come through the hastening of the development of better tractors. Probably the usefulness of the law as a regulatory measure was fulfilled some time ago, but in its other phases it appears that its value remains, and many remonstrances would doubtless be heard if an attempt were made to discontinue the tests.

A Quarter Century of Tractor Development

By E. J. Baker, Jr.[1]

A QUARTER-century of tractor development naturally divides itself into certain well-defined divisions, for history is neither a smoothly flowing river nor yet a series of water-tight dams. It is rather, a course of occasional placid reaches interrupted by rapids and other impediments to progress. Certain divisions of the tractor era might be stated as follows:

1. The period of engine development on the traction engine gear
2. The period of frame and transmission development with enclosure of parts
3. The period of redesigning for straight-line assembly.
4. The period of development of general-purpose models with their associated equipment.

One has to go back to 1892 to find the genesis of the farm tractor, for it was in that year that the Van Duzen Gas and Gasoline Engine Company, of Cincinnati, built an internal-combustion engine on the order of John H. Froelich, an Iowa thresherman, to be mounted on a traction engine gear. The machine ran, pulled its separator over the road, and threshed thousands of bushels of grain. The success of this machine led Mr. Froelich and others to organize a company to produce similar machines, and this company was the predecessor of the Waterloo Gasoline Engine Company and the John Deere Tractor Company. But the early manufacturing activities of this company were on farm engines rather than tractors.

Tractor manufacture started about 1898 and shortly after with the development of machines by Huber, the Kinnard Press Company, and Hart-Parr. Engineering effort was directed primarily towards making the engines more reliable and more economical in fuel consumption, and the Winnipeg Motor Competition was conducted to bring out these features.

The transition to the second period of development came, in my opinion, with the development of the 1913 model Wallis "Cub." This machine was the first of the "frameless" type, in which the crankcase and transmission housing provided the backbone of the machine. It was characterized by the enclosing of all moving parts in the transmission train, except the final drive gears, and it was but a logical step to the development of live-axle models with all gears enclosed.

It is quite probable that this Wallis "Cub" gave Henry Ford the idea which he later developed in his commercial tractor, for it should not be overlooked that Mr. Ford had experimented with tractor designs from a very early period, but the only fundamental feature of his early models that was carried over into the Fordson was small size and light weight. Once he adopted the frameless design, the rest was but detail.

When one attempts to evaluate this early work, in which traction engine gearing was metamorphosed into heavy-duty automotive transmission trains, it is impossible to overlook the constructive work of the Hyatt organization as then directed by C. M. Eason. They carried the vision of precision manufacturing to a frankly skeptical industry, and by tactful but unremitting pressure brought the industry out of the foundry and into the machine shop.

The third period, that of redesigning for straight-line production, through which Ford, of course, never had to

[1]Associate editor, "The Farm Implement News." Mem. A.S.A.E.

The 1913 Wallis "Cub," first of the "frameless" type cf farm tractor with enclosed transmission, which marked the beginning of the second period in tractor development. This general type, with refinements, and redesigned for straight line assembly has become the standard farm tractor of today

pass, was forced upon the remainder of the industry in order to meet Fordson competition. It was a case of a new deal or quit. The first of these newer models, designed as much for low-cost production as for proper functioning, were the McCormick-Deering 10-20 and 15-30. Production of machines of this type calls for extensive investment in specialized types of machine tools, the cost of which can be amortized only when volume sales can be maintained.

The fourth period, as it exists today, might never have come but for the vision and persistence of one man, Bert R. Benjamin. We may as well call it the Farmall era as anything. Its chief characteristic is a blending of all that had been learned about low-cost production of long-lived tractors into a radically original type of machine so designed as to permit its use as an empowered implement, whose time and labor-saving capacities would be so great that few farmers in row-crop territory operating on a relatively extensive scale could resist the economic appeal of this type machine, a number of which other than the Farmall have been developed in recent years.

This fourth period of tractor development has not been passed by any means, for one of its characteristics has been the constant designing of new types of implements to work with these general-purpose tractors. Every season brings something new, and usually with increased capacity for crop cost reduction. Many are dependent for their operation upon the power take-off, an idea developed back in 1906 by Albert Gougis of France but not commercially exploited until the post-war period.

There is a basic difference between the so-called standard type of tractor and the general-purpose type. The former is essentially a straight draft machine—a land locomotive—which may run on wheels or tracks. It can be and has been designed by mechanical engineers having little familiarity with actual farm work. One may be justified in saying that tractor development through the third period was a problem of mechanical engineering.

When one analyzes the overall design and functioning of successful general-purpose tractors, one notes at once how the design of the mechanical engineer has been adapted to the requirements of agriculture by the agricultural engineer. The laying out of a successful general-purpose tractor calls for a familiarity with crops, soils and topography. Such factors influence height, clearance, tread, center of gravity, turning radius, attachment points ahead, behind and beneath.

There were many efforts made to design general-purpose tractors before a successful one was produced. The handicap to the early designers was inadequate knowledge of farming. They had not sufficient agricultural engineering training. Only the farm equipment industry could originate the general-purpose tractor.

What of the future? In these years when the curve of invention rises at a constantly accelerating rate, one can hardly do more than guess at the future. Yet we can see now the beginnings of certain lines of investigation.

There is what has been called the traction battle—rear wheel drives vs. four-wheel drives, and all wheels vs. tracks. Tip-toe wheels with edge rims are finding their advantages and limitations under varying conditions as compared with lug-equipped broad wheels. Under present conditions of operation of tracks and development of enclosures, should track bearings be of chilled iron readily and cheaply replaced, or precision roller bearings with a life expectancy equal to that of the tractor itself? None of these problems has been worked out to the point where a solution under given conditions can be set down in an engineering handbook.

Then there is the fuel problem which arises out of the urge to make the tractor develop its power at the lowest possible cost. Since the fuel problem varies in different parts of the world, so the problem of engine design differs.

Petroleum refining in the United States is headed for a goal where practically any desired hydrocarbon can be produced from any other. Low-grade cheap fuels, it would seem, will be available only so long as there is a surplus of crude oil that must be marketed in competition with coal. With a decrease in crude production, it is likely that we shall have a period of still relatively cheap but high-grade fuels only. If this is the prospect, the market for automotive type Diesel engines in the tractor trade will be principally for export markets. Already there is talk of tractors available with either gasoline or Diesel engines interchangeable on the same chassis.

Last but not least, the final word has not yet been written on the question of two cylinders vs. four. Production man-hours per tractor are a factor that will have increasing study, if and when competition ever reverts to the conditions of 1921 and 1922.

The Machine Designer's Achievements

By C. O. Reed[1]

HISTORIANS, sociologists, economists, agricultural authorities emphasize the influence that farm machinery has had on our national life, but seldom do we hear praise to the genius who makes advancement through machinery possible—the machine designer. It is he who must combine engineering skill, knowledge of agricultural conditions and practices, and wide field experience into successful mechanical units, which not only meet the demands of a peculiar buying public, but which also point the way to new methods, to new systems, to greater progress.

Just as the designers and builders from 1831 to 1907 accomplished feats which were at first thought impossible, so, too, have the successors to those pioneers continued through the past twenty-five years to dream and to work wonders. Probably there have been fewer fundamental changes in implements during this latter period. On the other hand, almost the entire tractor development is crowded into the past two and one-half decades, and during that time the entire subject of farm machinery has become extremely complex. From these standpoints there is some justification to the claim that the accomplishments of the quarter century just closing may have been as great as those of the former period of three times greater duration.

When the American Society of Agricultural Engineers was born, agriculture was on the threshold of a new era being ushered in by the gas tractor. This "'bull in the china shop"—to use a homely, but very expressive simile—was destined to shatter practices built around horse-drawn machinery. Since the advent of the tractor the machine designer's problems have become so complicated that he now looks back upon the horse days as mere play. No matter what his tendencies may be, the designer must still respect the "horse-drawn trade," and keep improving units for that branch of the business. Also, during the transitory period he must reconstruct many of the fundamental elements of the old line into adaptations for tractor use. In addition he must design entirely new units for mechanical power. All the while he is chafed because the trade will not permit him to "wipe the boards clean" and produce the rather revolutionary units which he knows must come.

As an example of the versatility of the implement designer, and of the speed at which he must work, consider the range of accomplishment, within a comparatively short time, in plow construction. Twenty-five years ago the designer had to jump quickly from the horse gang plow to eight, ten, and twelve-bottom, independent-lift gangs for the large tractors that appeared rather suddenly. Then, as the trade tended to swing toward the small tractor, the success of power farming depended in no small way upon what the designer produced to accompany the light power unit. The machine designer met the challenge of the day by unique construction in the light, moderately priced, two-wheeled and two-three-wheeled tractor plows which have carried power farming onto thousands of farms in both hemispheres.

With agriculture tasting the conveniences and advantages of power units, and seeking greater adaptation of them to farming processes, the stage was soon set for the general-purpose or row-crop tractor. This type of power unit presents many real and interesting problems. How well the implement designer is meeting these problems is shown by the fact that we are now using, as attachments to the tractor base, the working elements of planters, cultivators, mowers, and pickers. If the implement unit has thus far appeared too cumbersome to use as an attachment to a tractor base, the designer has taken advantage of the power take-off for the torque requirements of the implement. Power binders are a good example of this class; we even have the tractor-hauled, power-driven manure spreader. Producing implements of this kind is not simply a matter of redesign at the point of power entry. Such machines must carry detailed changes at many points to accommodate new condition of speeds, capacities and strains.

Inasmuch as tractor development is treated in another article in this issue, this brief review of the machine designer's accomplishments will be confined mostly to the field of implements and power-driven machinery. Nowadays the engineering department of a manufactory producing a full line of farm machinery consists of two groups of engineers—the tractor designers and the machine or implement designers.

These men must work together closely in interlocking fields, yet the problems of these two classes of engineers are quite different.

The tractor designer, with the implement designer's problems in mind, is concerned with three or four general types of tractors; he is involved in considerations of temperatures, altitude, fuels, and topography; he must interest himself in some phases of soils and crops, and he always has before him the technical problems of refinement of product. His tasks are hard, and unstinted praise is due tractor designers, whether they be in factory, college, or farm, for rapid progress in power units during the past twenty-five years.

But the implement designer's field covers a vast range of design from the intricacies of soil-working surfaces to the efficiency of elements in machines that prepare produce for market. The machine designer must know the peculiar requirements of a wide range of soils. He must understand the technique of and reasons for many different crop practices, and watch for every opportunity to simplify processes whether it be by combining operations, by elimination, or by substituting new methods.

During the past few years some very pertinent questions have been asked regarding the validity of old meth-

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Ives Hall, the agricultural engineering building at Ohio State University, named in honor of Frederick Walter Ives, who designed it but did not survive to see it built. It houses the agricultural engineers who will be host to A.S.A.E. at its 26th annual meeting, June 1932

ods of seedbed preparation, of cultivation, and of harvesting small grains and corn. Cotton culture and cotton picking are on the verge of revolutionary methods. It is indeed a fast moving and a rapidly changing world in which the implement designer works. Yet his real testing laboratory must be the farm field, and his experimental season, by the very nature of things, is short.

The machine designer continually must keep in mind the shortcomings of the average operator of the implement. He would like to build into his product additional adjustments and other features to increase the efficiency of the machine. But the designer is face to face with the cold practical fact that the farming public as a class—particularly regarding implements—still sees the first cost of the unit before it appreciates higher quality that means greater efficiency.

During the past twenty-five years some of the old practice of "cut and try" has given way to scientific approach; there has been increased application of technical engineering principles, and the designer has been quick to accept the improved materials and processes developed by the science of metallurgy. As a result we notice refinement of produce expressed by trimness of design, greater simplicity, increased durability, and the use of better elements such as improved bearings. Marked progress has been made in standardization of types as well as in machine parts, and in the farm machinery business standardization is neither a small nor an easy task. Another problem, which the designer has faced successfully, is design that lends itself well to the improved, factory production and assembly methods which have come into vogue so rapidly during the past two decades.

When we consider the vastness and complexity of the implement field, the handicaps under which the designer works, the rapidity with which the agricultural picture is changing, and then truly appreciate the progress to date, it seems that the Silver Anniversary of the American Society of Agricultural Engineers can truly mark the closing of twenty-five years of real achievement on the part of machine designers. But no true member of that order of diligent, persistent, and modest workers will admit that any task is done. Each looks ahead eagerly for opportunity to express his talent in the bigger, newer things yet to come.

In the immediate future we probably will witness some fundamental changes in types of machines. The ground work for these is already being laid. Such changes permit new or improved farming practices. In turn, changes in agricultural methods offer new opportunities for machine design. Thus progress results through a complex evolutionary process in which it is hard to tell whether farm machinery is a cause or a result.

Some credence must be given the theory that, as agriculture becomes increasingly competitive, commercial production will retreat largely to the areas most favorable for it. If this occurs, farm machinery will hold the key to success, and upon its advancement will depend the size of farm and the processes for greatest net profit. In those days, commercial farming—in contrast to "existence farming"—will be carried on by men of whom every designer now dreams. Such men will be business men who demand high quality machinery and are willing to pay for it. In the more distant future, then, the machine designer may have the pleasure of serving a more select clientele with higher quality design and construction as well as with new types of units.

The Agricultural Power Take-Off

By W. Leland Zink[1]

TWO methods of applying tractor engine power, the belt pulley and the drawbar, have been in general use since the early introduction of the internal-combustion-engined tractor. During recent years the power take-off, a third method of applying tractor engine power, has come into very general use. This type of power application might be more fully described as a tractor attachment or provision for applying tractor engine power direct to the operating mechanism of a mounted or coupled tool while traveling.

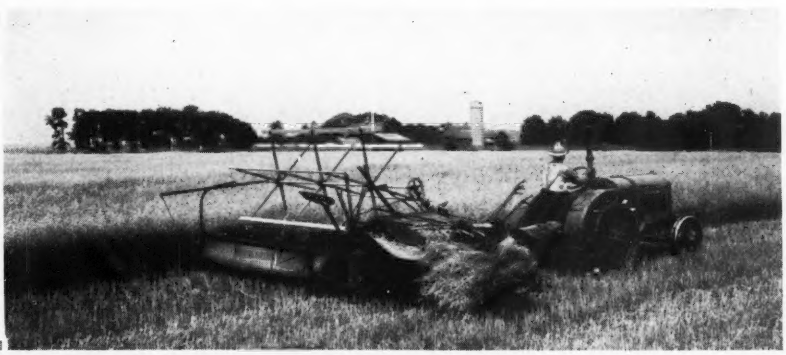
The early history of the development dates back to 1878, when a power take-off driven reaper was exhibited at the Paris Universal Exposition[2]. The header design of this reaper permitted only vertical motion relative to the steam tractor to which it was attached, thus permitting the use of a very simple chain drive. Some of the early steam tractor plowing outfits utilized steam for lifting the plows. Both air and hydraulic arrangements have been used for years in the control of heavy industrial graders, hoists, and leveling equipment. It seems that the first power take-off installation providing a steady application of direct motor power for replacing a bullwheel drive and providing for both lateral and vertical motion of the driven tool relative to the tractor, was designed and built by Albert Gougis, a Frenchman, in the year 1906. This French power take-off[3] was developed especially for the driving of a grain binder so as to successfully handle down grain. Although this machine was used with success until 1918, it seems that this invention was considerably ahead of its time. It is reported that this tractor is now on exhibit at the Museum of the Institution Agronomique in Paris.

The credit for developing the first commercially prac-

[1]Chief engineer, General Implement Company. Mem. A.S.A.E.

[2]Farm Implement News, September 18, 1930, p. 25.

[3]Farm Implement News, February 12, 1931, pp. 20, 21.



A modern one-man, power take-off operated, binder with important controls arranged for operation from the tractor seat. Although the power take-off is still a very new development, it is now being applied very successfully to a great variety of field operations from the preparation of the seedbed, planting, cultivating and pest control through all the operations of harvesting. It will prove to be one of the most outstanding factors in the application of mechanical power to agriculture

Plowing, harrowing and drilling in one operation with the aid of the power take-off

tical power take-off should go to Bert R. Benjamin of the International Harvester Company. Although that organization had worked with power take-off equipment as early as 1916, their first tractor designed for power take-off use went on the market in 1922[4]. To John Powell, of Kokomo, Indiana, considerable credit is also due. This man it seems first provided a revolving shaft on a tractor of his design for use in operating a power lift. About the year 1920, while trying to operate a corn picker with one of these tractors under muddy conditions, Mr. Powell conceived the idea of using his revolving power-lift shaft to drive the corn picker. From the encouraging results of this hook-up evolved the first successful two-row corn picker. It might be interesting to note that the weight of this two-row picker when completed was less than the single-row ground-drive machines of that day.

It was not until about the year 1925 that the power take-off became generally known. Probably the successful use of the power take-off in saving the rice crop of that year in the states of Arkansas, Louisiana and Texas during a very wet season, did more to establish the possibilities of the equipment than any other one thing. Suddenly almost every tractor manufacturer was forced to develop power take-off equipment. At first very few designers seemed to realize the possible wide application of this equipment. A glance at the small size of the rotating shaft and the light construction of some of these early power take-off attachments quickly proves this fact. Practically no one seemed to realize the importance of standardizing this equipment. For the most part, the prevailing idea was to hang on some kind of a rotating shaft regardless of its capacity, drive efficiency, type of ending, safety features, or location relative to the hitch point or tractor center line. Fortunately these designers did in most cases agree on the direction of rotation, and that the speed should be some where around 500 rpm.

With this very sudden power take-off growth, without definite standards at hand or a general idea of the problems involved, a lot of difficulty arose. This condition was especially bad when hooking power take-off driven implements onto tractors built by another manufacturer. During the latter part of 1926, representatives of the various companies building power take-off equipment met in Chicago under the auspices of the American Society of Agricultural Engineers to discuss power take-off problems and standardization. Between that time and December 1930, a number of important power take-off discussions were held. Oftentimes it was a question of thoroughly understanding the principles involved, rather than the adopting of some specific recommendation or standard. As one engineer once said, after several consecutive sessions, "There is a lot more to this power take-off and its problems than even most engineers consider." Naturally, with representatives coming in from several companies, there were some heated arguments, especially on some items. Oftentimes special laboratory tests were resorted to to get sufficient data to work on.

Some items, particularly splines, often supposed to be thoroughly standardized by other engineering groups, were found to be lacking in detail. By much hard work, however, and a willingness to cooperate for the good of the cause, we now have a very complete set of power take-off standards, which have recently been adopted by the American Society of Agricultural Engineers[5]. These standards have been drawn up with the thought of good engineering practice as well as a careful consideration of the equipment now in use. If the manufacturers will cooperate in future designs to make their power take-off equipment conform to these standards, it will only be a short time until it will be possible to quickly hook a tool provided for power take-off operation onto any tractor which can be fitted with a power take-off attachment.

Although the power take-off is still very new, we find this type of power being applied to practically every field operation from the preparation of the seedbed, planting, cultivating, pest control, through all harvesting operations. Modifications of the power take-off, such as the power-lift, are now being universally applied to the mechanical control of various agricultural machines. The reasons for this very rapid growth can be attributed to three things: (1) The 80 per cent or higher efficiency with which power may be applied by the use of it, as compared to a 50 per cent efficiency or less by using ground wheel drives; (2) the positive drive provided either while traveling or standing still, and (3) the possible elimination of weight both on the tractor and driven tool. In certain cases, the final success of a type of implement has been due to the power take-off. The corn picker seems to be a good example of this. With these decided advantages, it appears certain the power take-off is with us to stay.

With this rather sudden growth, it is difficult to visualize just how far this development may go. No doubt, however, extensive use will be made at an early date of motor-generator drives. Considerable effort will no doubt be made in the application of air or hydraulic equipment to the controls, lifts, etc., of agricultural implements just as has been done in the case of industrial equipment.

One of the most interesting possible developments seems to be the design of a tractor provided with two or more governed speeds. In such a tractor the lower governed speed would develop the traction capacity of the tractor at the safe ground travel of the implement. At the higher governed motor speeds the transmission gears might be shifted automatically so as to keep the same working ground travel at each governed speed. By absorbing the extra motor power through the power take-off, it would be possible to materially increase our tractor power output without increase of weight. It is admitted there are still many complications to this thought; however, there are some very interesting possibilities in an installation of this kind. A friction clutch for the power take-off shaft, independent of the ground drive transmission, is another construction feature offering a great deal of promise.

[4]University of Minnesota Bulletin No. 262, p. 50.

[5]AGRICULTURAL ENGINEERING, Vol. 12, No. 1 (January, 1931).

Engineering Development of Tillage Equipment

By Theo Brown[1]

FROM the earliest time man has tilled the ground that he might prepare a seedbed in which to sow seed and thus procure food. Necessity then was the mother of invention, so the first implement used to till the soil was a sharpened stick forced into the soil with the hand or foot. It was crude, but it did stir the soil; it made a seedbed and so aided germination.

Then the wooden hoe came into being fashioned like a plow and propelled by human power. Later animals were used for power. Then metals were used to increase the efficiency of the wooden plow. Then followed the wooden plow with an iron point and wooden moldboard covered with iron. The iron plow was then developed, followed by the chilled plow. Then came the plow using the steel moldboard and steel share. The beginning of the use of steel marked the disappearance of iron for the construction of tillage implements.

Coincident with the development of the plow was the development of the harrow. The first harrows were limbs of trees dragged over the plowed ground by man or beast to level and pulverize the soil.

Slowly, as the need arose and as human ingenuity was able to create and produce implements, machine production entered into agriculture. The development of machine methods in farming came with the development of new processes in other industries. Progress in the one was aided by the other; neither could have progressed without the other. Improvement in power, tillage, cultivating and harvesting implements have had a tremendous effect on agriculture, but just as great effect on other industries by releasing large numbers of agricultural workers to operate the other industries.

The development of tillage equipment has kept pace with new needs as they have presented themselves. This development has come up through the years from the sharpened stick, the wooden moldboard plow, the iron-faced wooden plow, the sulky and gang plows, disk plows and big engine plows.

The wonderful development of labor-saving, cost-reducing farm machinery has gone on. As the farming industry has grown, and with it the need for still further reductions in the cost of crop-producing operations, the agricultural engineer has met those needs in a practical and satisfactory manner.

As soon as a new tillage tool is brought out which fills an apparent need, the wheels are set in motion to improve its construction and performance.

High-grade steels are now used to lighten and strengthen construction, and heat-treatment adopted where necessary to strengthen parts. Hence, fewer repairs are necessary for maintenance, and at the same time implements are made more convenient to handle, are susceptible to finer adjustments, and better operation is made possible.

With the general-purpose tractor has come the 2, 3, 4, and even the 6 and 8-row cultivating equipment, the 6 to 8-row equipment being used in vegetable production. Wide-nosed shovels of sweep type are replacing the older types. The new shovels do not dig down and destroy plant roots, but are set so they over-lap in their work, covering all the row centers.

The necessity for lower costs of production is rapidly changing the methods of seedbed preparation for the wheat farmer. Modern sowing and harvesting machinery has made possible the handling of large acreages with but little man power. The individual farmer has found that he can sow and harvest a far larger acreage than that for which he can plow and prepare a seedbed.

Through the development of that tool variously known as the disk tiller, gold digger, wheatland plow, cylinder plow, one-way disk, the answer to the seedbed preparation problem of the wheat farmer appears to have been solved. It has speeded up seedbed preparation through the wheat belt so that large acreages may be prepared in a very short time after harvest, thus saving moisture and enabling individual farmers to keep their seedbed preparations up to the same relative speed as their planting and harvesting methods.

For the farmer in the arid regions where summer fallow practice is a necessity to crop production, we find the field cultivator equipped with either duckfoot shovels or spring teeth. This implement leaves the soil in a loose condition, conserves the necessary moisture and kills the moisture-consuming weeds.

Up to the present time agricultural implement design and manufacture has been one of devising, improving, strengthening, with the idea of fitting the product for better and more work—being in fact a process of evolution in which one design followed another as the need presented itself.

The development of the power-lift is a concrete example of what is being done to add convenience and ease to the operation of modern power machinery. It lessens the physical effort and increases the capacity for work.

At the present time tillage machinery appears to have reached a point of quite satisfactory development through a long period of more or less cut-and-try methods.

The problem facing agricultural engineers in the future would seem to be that of establishing a definite objective through careful analysis and consultation, then driving through to that objective, using the results of careful thought and research instead of the more or less cut-and-try methods of the past.

Cut-and-try methods and ordinery field trials will no longer supply the necessary data on which the designers of agricultural tools may base their efforts. Before the agricultural engineer or the implement designer and manufacturer can go forward with work of a specific nature, the goal must be pointed out in a definite manner through the cooperation of agronomists, crop specialists, soil technologists, and implement and agricultural engineers.

The great question is, "What are we trying to do?"


Further progress in implement development awaits research to determine more definitely what might be accomplished by implements and how it could be accomplished most efficiently

[1]Experimental department, Deere & Company. Mem. A. S. A. E.

Land Reclamation in the Mississippi Basin[1]

By H. B. Roe[2]

IN APPRAISING agricultural engineering achievements of the last quarter century in land reclamation in the Mississippi Basin, we should bear in mind the great contemporaneous changes of the period in both the methods and the equipment of agriculture, resulting, in the majority of cases, in the replacement of animal power on the farm with mechanical power and attendant new types of machinery.

From a land reclamation standpoint the most widespread result of this change has been the reduction, by millions of acres, of the crop land required as a source of feed for draft animals, thus largely eliminating need for making available large additional areas of new land to meet the demands of a growing agriculture.

A clearer comprehension of this effect of changing conditions may be had by a perusal of the accompanying table prepared from a careful analytical study of the U. S. Census Bureau records, those for 1930, still incomplete, being supplemented by estimates from the agricultural press.

Reclamation agencies have brought under cultivation 33 million acres of new land (an area nearly equal to the land area of Arkansas), but almost wholly within existing farms, adding the best crop acres without appreciably increasing the number of farms or the size of farms. Even at that these additions have fallen appreciably short (4,600,000 acres, or 12.3 per cent) of supplying the farmer's demands for additional crop land. Evidently, then, reclamation is not largely responsible for recent disturbing surpluses of agricultural products by reason of causing vast and unwarranted increases in agricultural areas.

The Division of Agricultural Engineering in the U.S.D.A. Bureau of Public Roads grew out of the Offices of Irrigation and Drainage Investigations established in 1907. In 1921 the present Division of Agricultural Engineering was organized to continue the work in reclamation together with that in farm machinery, structures, water supply, and sanitation, taken over from the Office of Farm Management.

The roster of achievements of the period, in land reclamation, by federal, state and private agencies, individual and co-operative, contributing largely to the growth and stability of agriculture, is imposing. Prominent among these achievements are the following:

In Irrigation, Drainage and Flood Control. More exact formulation of the laws governing water flow in open channels and closed conduits, safe design of reclamation structures, run-off, evaporation, transpiration and deep seepage; accumulation of facts concerning silt-burden accumulation and its movement and deposition in streams, flood stages and behavior of streams in flood, cost and efficiency of pumping systems and other operations concerned with irrigation and drainage, and available water supply on irrigation projects; development of efficient and economical machinery for the finished excavation of both open channels and tile trenches; and studies resulting in improvement in quality of both clay and concrete pipe used in irrigation and drainage.

In Soil Erosion. Studies of the extent of its ravages and the determination of effective methods for its control.

In Law. Evolution of modern drainage law furnishing the procedure for establishing community outlets and an effective constitutional method for financing such; and taking the first step toward making a community outlet an asset instead of a liability to the farmer of small means, in the precedent set by the Wisconsin Farm Drainage Law.

In Education and Publicity. Through extension, demonstrations and dissemination of bulletins suited to the needs of both technical and lay groups, ten thousand families have found a sustained hope and home on the irrigated areas of the Great Plains, millions of farmers in the humid regions have been lifted, simultaneously, out of the mud and out of the "slough of despond," hundreds of thousands of farm businesses have been converted from failure to success through tile drainage, and marketing, postal, school and social facilities in rural districts have been improved manyfold by the good roads development directly resulting from better drainage.

The economic hope of the farmer lies in reducing the unit cost of production. Reclamation has brought this about in thousands of instances in two distinct ways: (1) By increased yields through adding to the cropped area **the best acres** on the farm and by conserving their virgin fertility, and (2) by reduced cost of field operations through elimination of wet and waste spots and of small irregular fields followed by the resultant introduction of tractor power and its efficient auxiliaries. Effective use of tractor power demands firm dry soil and large uniform fields. From all over the basin comes the testimony that "the tractor follows the tiler."

In the light of past achievements one may now venture the following forecast of probable accomplishment by agricultural engineers in the land reclamation field in the Mississippi Basin in the next twenty-five years: (1) Greatly extended use of tile underdrainage in the improvement of farm lands and farm field conditions; (2) development of practical flood control measures for the Mississippi and its principal tributaries; (3) general adoption of the prin-

[1]Miscellaneous Paper No. 241 of the University of Minnesota, Department of Agriculture, Agricultural Experiment Station. Prepared expressly for AGRICULTURAL ENGINEERING.

[2]Agricultural engineer, University of Minnesota, Department of Agriculture. Mem. A.S.A.E.

TABLE OF STATISTICAL FACTS PERTINENT TO RECLAMATION DEVELOPMENT IN THE MISSISSIPPI BASIN, 1910 TO 1930, INCLUSIVE

Description of Item (Items in body of table apply only to Mississippi watershed)	General	Percent total in cont'l. U.S.1930	1910 report	1920 report	Incr. over 1910 report		1925 report	Incr. over 1920 report		1930 report	Incr. over 1925 report		Incr. over 1920 report		Incr. over 1910 report	
					units	per cent		units	per cent		units	per cent	units	per cent	units	per cent
Number states included wholly or partly	26															
Total land area, thousands of acres	—	41.0	—	—	—	—	—	—	—	775700						
Land in farms, thousands of acres	—	55.0	461685	509631	47946	10.4	—	—	—	508721	—	—	-910	-0.2	47036	10.2
Cropped land in farms, thousands of acres		59.0	193393	216491	23098	11.9	—	—	—	230672	—	—	14181	6.6	37279	19.3
Number of farms, thousands	—	45.3	2880	2921	41	1.4	—	—	—	2887	—	—	-34	-1.2	7	0.2
Average size of farms, acres	—	121.4	160.3	174.5	14.2	8.9	—	—	—	176.2	—	—	1.7	1.0	15.9	9.9
Tractors used on farms, hundreds	—	*58.0	No record	1591	?	?	2968	1377	86.6	*5500	2532	85.3	3909	245.7	?	?
No. farms for each tractor used	—	—	—	18	—	—	10	—	—	5	—	—	—	—	—	—
Originally wet land reclaimed by drainage, thousands of acres	—	*48.3	24819	42469	17650	71.1	—	—	—	56781	—	—	14312	33.7	31962	128.8
Originally arid land reclaimed by irrigation, thousands of acres	—	19.5	4350	5001	651	15.0	—	—	—	5077	—	—	77	1.5	727	16.7

*Items purely an estimate based on agricultural and technical press reports

ciple of the "Wisconsin farm drainage law" by the other states in the basin; (4) statewide drainage and water-resource surveys in every state, and formulation of a statewide plan of drainage, operative under the supervision of one central competent individual authority, and to which all future public drainage must conform; (5) formulation of the laws of soil hydraulics to the end of more economical and efficient design of tile drainage systems, determination of the optimum rates of drainage for optimum results in production of different types of crops, and determination of reliable methods of soil moisture conservation and control; (6) establishment of a uniform regulatory act in the various states for maintaining a high standard of quality in drain tile; (7) development of a soil conservation consciousness among all farmers by increasing knowledge of the menace of soil erosion and education in methods and practices for its control and prevention; (8) establishment of practice, by all agencies engaged in farm financing, of a requirement that all farm lands be protected by proper drainage and soil erosion control works, or that such improvements be definitely provided for before requested loans on said lands be approved; and (9) the development of a more complete understanding of the inter-relationships between the other groups of the American Society of Agricultural Engineers and the reclamation group to the furthering of the great ends of the Society as embodied in its platform.

The forecast just outlined may be thought by some to commit us to too vast a contract. To such it is suggested that they take courage from achievements of the past, that they observe the nature of the curve of progress, and that they remember that the American Society of Agricultural Engineers has defined **land reclamation** as "putting agricultural land to that use in which it will render the largest possible benefit both to the owner and to the general public—whether this be the production of crops or the furnishing of recreation—and increasing the benefits to be obtained by the proper use of that land to the highest point commensurate with the cost involved."

Land Reclamation in the Eleven Western States

By W. W. McLaughlin[1]

IT IS interesting to note that the beginning of the period of more scientific land reclamation and the organization of the American Society of Agricultural Engineers were practically contemporaneous.

Twenty-five years ago the West had practically passed through the period of easy land reclamation and the earlier speculative era. It had been shown that there were great possibilities in land reclamation, but at the same time it was becoming obvious that the era of low cost was about over, and also that under existing conditions the construction of costly enterprises by private capital was usually disastrous to the investor.

Congress had investigated land reclamation, especially by irrigation, and had created two offices charged with the study of reclamation conditions and the construction of irrigation works. The first of these was provided for in 1898 by an appropriation for irrigation investigations, to be carried on under the direction of the Secretary of Agriculture. This work has been continued until it has reached its present status in the division of agricultural engineering, Bureau of Public Roads. The second office created was the Reclamation Service created by the Reclamation Act of June 17, 1902. At first this was a branch of the U. S. Geological Survey, but it has since become an independent bureau.

By the year 1906 both of these agencies were well established. The Divisions of Irrigation and Drainage Investigations under the Office of Experiment Stations had collected much valuable information regarding the duty of water in irrigation, cost of irrigation and drainage, works, etc., and the Reclamation Service had done much preliminary investigational work and had selected for construction, and in several instances begun work upon, irrigation projects scattered throughout the western states.

In general, however, the irrigation status changed but little between the years 1898 and 1906, excepting that irrigation and drainage had assumed national importance and become universally recognized as important factors in the development of the West. However, although irrigation was well established, it was generally conceded that the use of direct flow water was rapidly approaching its limit. I well remember how twenty-five years ago, and even for several years earlier, the belief generally prevailed that, without expensive storage, irrigation had about reached its practical limit in the West. Nevertheless, the preliminary data of the 1929 census show that the irrigation acreage of the eleven western states has more than doubled since 1902, and the end is yet afar off. Although the acreage involved is not as great, the drainage situation is still more striking in that by far the greater part of the drainage development in the eleven western states has taken place in the last twenty-five years. It appears from the 1929 census data that in these states the irrigated acreage had more than doubled between 1902 and 1929, increasing from 8,471,641 acres in 1902 to 17,503,908 in 1929, and that in 1929 the area of drained land that had been planted was 3,690,039 acres.

The elements entering into this notable increase are of varying degrees of importance, but are related to agricultural engineering. The space allowed for this review permits only the briefest possible summary. Some of the more important are the following:

Increase in the Duty of Water. Both research and experience in irrigation have demonstrated the importance of using the correct amount of water. Research regarding the water requirements of plants, depths of root zones, field capacity of soils, percolation factors of soils, etc., together with practical demonstrations, have greatly increased the duty of water, so that practically unchanged supplies are

[1]Associate chief, division of agricultural engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

A Parshall measuring flume in an irrigation ditch

(Right) An irrigated cotton field in Texas. (Extreme right) Row-crop irrigation. The water had just been turned into this field shortly before the picture was taken

now capable of irrigating much more land than seemed possible twenty-five years ago. Similarly, improved methods of land preparation, of conveying water with decreased losses, and of its application, such as the employment of the furrow, border, raised-contour terrace, check, and basin methods, have done much to make more efficient the available supplies.

Design of Irrigation Structures. Associated with the promotion of greater efficiency in the distribution and application of water for irrigation purposes, and also in connection with drainage, has been the great advance in the design of irrigation structures, both small and large. Concrete and steel have, to a great extent, taken the place of wood, insuring lower operation and maintenance costs with greater efficiency.

Storage of Flood Waters. Provision for the storage, in both artificial surface and natural underground reservoirs, of waters that had previously been going to waste, has been made mostly within the last twenty-five years. This has resulted not only in increasing the supply of water directly available, but it has also made possible the distribution of water over longer periods of time. This makes practicable the raising of late and more valuable crops, and in some sections, two or three crops per year, thus materially increasing the productivity of the land and its net return to the farmer.

Pumping of Subterranean Waters. The use of underground water has noticeably increased; in fact, it may be said that the major part of the area irrigated by pumping in 1929 has been reclaimed within the last twenty-five years, and mostly within the last ten. The preliminary announcement of the 1930 irrigation census for the entire country contains this statement: "The increase in the total number of active irrigation enterprises from 63,298 in 1920 to 74,863 in 1930 was attributed principally to the wide-spread adoption of pumping from wells, especially in California." An important factor in this development is the construction of hydroelectric power plants as adjuncts to storage reservoirs.

Drainage and Alkali Studies. The reclamation of water-logged and alkali lands has developed rapidly within the last few years, resulting in material increases in the area of reclaimed land.

Reclamation Economics. A better understanding of the economics of reclamation has materially assisted in sane development. Studies regarding the availability of markets, varieties of crops possible and profitable, transportation, land settlement, preliminary costs of reclamation, maintenance, operation, taxation, and other incidental but necessary adjuncts, have been of great importance.

Improvements in Irrigation Laws. Of especial value has been the great improvement and better understanding of irrigation laws pertaining to water rights, the distribution of water, etc., that has taken place. The improvement and development of irrigation district laws has been particularly marked as has also the procedure regarding the adjudication of water rights. Careful studies regarding corporation and community enterprises of various kinds have done much to increase confidence in and assure stability to many irrigation projects.

Measurement of Water. The importance of accurately measuring the water used in irrigation has been especially emphasized within the last few years and methods of making measurements have been greatly improved. This has resulted in a much better distribution of water.

WHAT OF THE FUTURE?

The foregoing are only a few of the many factors entering into the marked increase in land reclamation that has taken place. That the increase is not primarily due, as many think, to construction by the federal government, is evident since the latest estimates available (1929) show that only about 1,500,000 acres are now being irrigated by federal projects and of this area a portion was irrigated prior to federal participation. Detailed census estimates for 1929 are not yet available, but the proportions will probably not be materially changed from those given in the 1919 census report which showed that only about 8 per cent of the total irrigated acreage of the country was due to government construction, all of the remainder being due to other agencies. The general increase is clearly due to improved methods and a better and more complete utilization of available supplies, construction by the federal government being an incidental contribution rather than a major factor.

It appears that we have passed such preliminary phases of reclamation as the eras of individual effort, investment of private capital, speculation, community government, and war-time efforts, and have reached a state of sane development and readjustment. The test of the feasibility of reclamation is, and always will be, its ability to successfully meet and withstand competition. The endeavor of the agricultural engineer must therefore continue to be along sound agricultural engineering lines, sound not only from the standpoint of engineering, but also on the economic side. The perfecting of existing enterprises and undertakings, the consolidation of existing systems, one of the most important needs of the day, in order that waste may be eliminated and efficiency promoted, must be especially stressed. Efficient use of the available water supply must be the problem of the agricultural engineer in the future as in the past, and allied with this must be the improvement of operating administrative methods, a better preparation of the land, both surface and sub-surface. More attention must be given to the crops raised from the standpoint of water utilization. Better laws and financing methods, probably upon the basis of agriculture as an industry, the improvement of farm machinery, housing, and living standards, and, finally, building for the stability of the industry and the success of the operator still demand the attention of the agricultural engineer. The further improvement of irrigation practice, utilization of available water supplies in the non-growing months, the conservation of waste production and fertility of soil, the prevention and curing of erosion, the development of storage in both underground and surface reservoirs, power farming, utilization and development of by-products and the coordination of industrial with agricultural uses of water are a few of the fields to be covered. With reference to all types of land reclamation—irrigation, drainage, terracing, cut-over and eroded land, and others—it is sufficiently obvious that throughout the entire country, new lands must and will be reclaimed and more efficient methods of crop production be found by the agricultural engineer, as economic conditions warrant.

The Flow of Underground Water

By Walter W. Weir[1]

STUDIES on the flow of underground waters by Hazen, Slichter, and other workers of the U. S. Geological Survey, were made many years ago, and the formulae developed by them have been accepted generally by other workers. These men were particularly interested in the velocity of flow of underground water and used laboratory methods with many of the variable factors under control. More recently work has been done by members of our own Society, having in mind the development of underground water supplies for irrigation, the removal of water by drainage, and the effects of both surface and subsurface diversions upon these underground waters.

Marr[2], Jessup[3], and I have studied the effects of pumping for irrigation and drainage on the ground water table and made observations on the relation of the various subsoil strata to the delivery of water to pumps. For the most part, these investigations have been made in the field with all of the varying factors which field studies encounter. This work differs from that of Slichter and the other early workers in that it deals more with the problems of practical rather than theoretical interest.

Neither Marr nor I have studied underground waters from the standpoint of determining flow rates through strata of various kinds, although we have observed, in connection with drainage pumping, the rate of flow to wells, the shape of the drawdown curve, and the rate of water table recovery after pumping ceased. These are very important factors relating to the number, capacity and effect of wells and pumps having a specific duty to perform, such as the lowering of the water table for drainage. We have observed that, although the surface of the water table may in its normal condition have a slope of several feet per mile in some particular direction, there is no appreciable difference in the shape of the drawdown cone between the higher and lower sides of the well. This would indicate that the lateral movement of water through these soils is very slow. On the other hand, the recovery of the water table after the cessation of pumping is so rapid as to indicate considerable water movement. It is believed that this movement is vertical rather than lateral and consists very largely in a readjustment of static head. Similar observations have been made by me in studying the shape of the water table in the vicinity of tile or open drains.

Some of the latest published material on ground water movements is by Lewis[4]. He has developed formulae for the drawdown curves in wells when the static head varies from that sufficient to give true artesian flow to that which is only sufficient to fill the waterbearing strata. These studies have been made under actual field conditions with wells and pumps installed for the drainage of irrigated lands. The general conclusion to be drawn from this work is that "if the area to be drained is more than a few hundred feet in diameter, successful drainage will depend on a general lowering of the water table. To secure this lowering, wells should be designed to have the greatest possible capacity with an economical lift."

McLaughlin[5] and Israelsen[6], working in Utah, have under way rather elaborate experiments from which they hope to determine the rate of movement of water through fine-textured soils and the relation of the water table to the plane of saturation.

McLaughlin and his coworkers have also instituted ex-

[1]Associate drainage engineer, University of California. Mem. A.S.A.E.

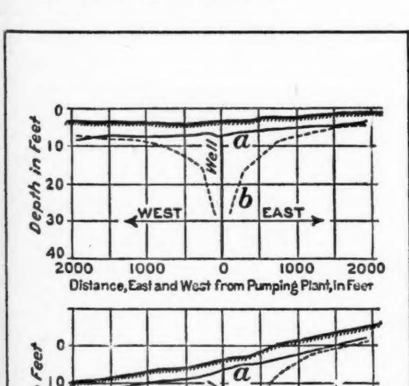
[2]Marr, J. C., Irrigation engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

[3]Jessup, L. T., Associate drainage engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

[4]Lewis, M. R., Irrigation and drainage engineer, Oregon State College and U. S. Department of Agriculture. Mem. A.S.A.E.

[5]McLaughlin, W. W., Associate chief irrigation investigations, U. S. Department of Agriculture. Mem. A.S.A.E.

[6]Israelsen, O. W., Irrigation and drainage engineer, Utah Agricultural College. Mem. A.S.A.E.



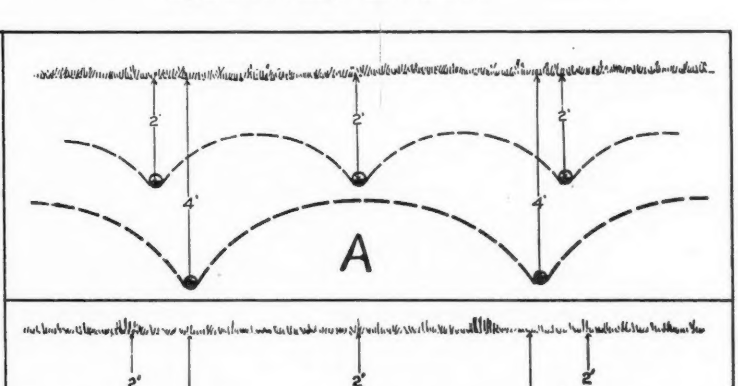


Fig. 1. (Left) Ground water curves (a) before pumping and (b) during pumping, in Salt River Valley, Arizona. (Marr, J. C., U. S. Department of Agriculture, Department Bulletin No. 1456, 1926.) Fig. 2. (Right) Studies on the shape of the water table in tile-drained land have resulted in a new conception of the movement of water into a tile. The old idea has been that the water table between tile lines is elliptical (A) with the principal movement being lateral, whereas the new idea is that the water table is practically parallel (B) to the surface and that the principal movement is vertical. (Weir, W. W., Shape of the water table in tile-drained land, University of California, Hilgardia 3: No. 5.)

periments in southern California for the study of the practicability of increasing ground water supplies for irrigation and raising the ground water table by diverting the flood flow of streams to areas where the water can be stored in the soil and later become available for pumping. This field of study has tremendous possibilities as it may show the feasibility of using ground storage for large quantities of water which are now wasted, and in the elimination of costly storage reservoirs in the mountains. In many cases water from the lower water sheds is not subject to storage in surface reservoirs, but may be saved through ground storage. The depletion of underground waters in some of the more intensively pumped areas of the western states has become a serious problem and this field of study becomes one of great practical value.

The knowledge that lateral ground water flows are exceedingly slow, except in gravels and coarse sand, and that the most active water movements are vertical, has led to a new conception of the function of both drains and pumping plants. The spacing and depth of tile drains has been fairly well established as the result of long experience, but the hydraulics of the flow toward them is not so well known. The same thing applies also to pumping plants whether used for the sole purpose of obtaining water for domestic use or irrigation, or for the relief of poor drainage conditions.

Investigations now being conducted under the direction of Adams[7], in which he and his coworkers are primarily interested in irrigation pumping plants, involve all of our knowledge of ground water movements, and workers on the federal and experiment station staffs throughout all of the western states are contributing to our knowledge of this phenomenon. Probably the most valuable theoretical

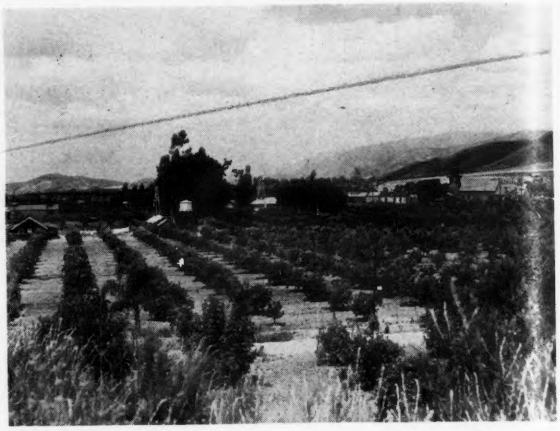


Fig. 3. A knowledge of the conditions governing underground water movement is essential to the fruit industry of California which in many regions depends largely on pumped water for the supplying of adequate irrigation

data have come from the U. S. Geological Survey, but such investigations as were recently made by the A.S.A.E. Committee on Irrigation on methods of estimating capacities of wells from well logs, should not go unmentioned.

The field of the hydraulics of underground water movements is still open and there is much yet to be learned. This is especially true in regard to the practical application of the principles involved in pumping for irrigation and drainage, and the storage of water in underground reservoirs for future use and all that is implied by these activities.

[7]Adams, Frank, Professor of irrigation investigations, University of California. Mem. A.S.A.E.

The Relation of Reclamation to Efficient Operation of Machinery

By John Swenehart[1]

DO WE need more land in cultivation, or which land do we need? The answer is the essence of a new concept of land reclamation. The old idea of reclamation was the bringing in or subduing new land from nature. The first effort was to get production as quickly as possible with little or no attention to the efficiency of the operation.

In 1902 the so-called Reclamation Act of Congress started the building of great irrigation works. This work has loomed large in the popular mind; in fact, the word "reclamation" in the public mind is almost synonomous with dry-land development. The total area, however, involved in this phase of reclamation is insignificant, and in many cases secondary factors, due to the building of reservoirs and irrigation works, have more bearing on our national welfare than the few acres of farm land improved.

The new idea of land reclamation as now accepted by agricultural engineers and other agricultural leaders is much broader in application. It is accepted to include drainage, irrigation, soil erosion control, land clearing, stone removal, and forestry. Naturally, it includes the maintenance of all of these. This idea of reclamation is selective and recognizes that the farmers may wisely invest money, in what may be termed "re-reclamation," since much of the land where reclamation effort is now being expended was first to be occupied in the development of American agriculture. This "re-reclamation" represents a major problem in Pennsylvania, New York, Wisconsin, North Carolina, Louisiana, as well as California.

[1]Manager, agricultural section, Atlas Powder Company. Mem. A.S.A.E.

Land reclamation and farm machinery are probably most frequently blamed for our present surplus of production and consequent collapse of prices. While the justice of this claim at first seems obvious, there are a number of facts which challenge consideration.

In the three lake states alone—Minnesota, Wisconsin, Michigan—during the past twenty-five years, over 75 million pounds of explosives have been used on farms to make possible a most remarkable land improvement. This reclamation represents not the bringing in of new land from nature, but rather the complete improvement of already existing farms. Just as factories are rebuilt or improved, so good farmers in our older developed regions are making their farm factories ready for modern power and machinery.

The five states of New York, Pennsylvania, Ohio, Michigan and Wisconsin, all now among the ten highest states in the number of tractors on farms, show increases of over 500 per cent in the last ten years. All of the other leading tractor states, such as Illinois, Iowa, Kansas, Minnesota, Indiana and California, show average increases of only about one-third as much in the same period. In 1920 Kansas, Minnesota, North Dakota, South Dakota and Nebraska ranked third, fourth, sixth, seventh, and eight, respectively, in the number of tractors. In 1929, they dropped to sixth, eighth, fourteenth, fifteenth, and thirteenth places, respectively.

It is of interest also to note that each of the states of Indiana, Ohio and Pennsylvania now exceed Minnesota in wheat production. In other words, the rapid increase in the use of machinery is shifting from the open prairie to the northeast central and northeast states.

Low prices bring out the importance of efficient production, since inefficient producers are first affected. Low prices emphasize freight transportation costs. Nearness to markets and low freight charges make desirable the reclamation of land near centers of consumption. The Pennsylvania potato farmer has from one-fourth to one-third advantage over his competitor in Maine or Michigan.

Mere existence of improved land is no justification of continued use. Obsolescence may come with land as with factories or machines, not because of wear but because conditions change.

The use of power determines to a large extent the wages of labor. The farm has always had difficulty in securing good labor against the competition of high wages from manufacturing industries. The additional earning power of a man using good farm machinery justifies a wage comparable with that in urban industry. This factor is frequently neglected in land studies. There seems to be a direct relation between the horsepower per farm, the income from that farm, and the crop acres per worker. Obviously, the Iowa farmer is in a better position to compete with outside industry than the Alabama farmer.

Horsepower, Acreage, and Production*

State	Horses, or equivalent per farm	Crop acres per farm	Index of volume of production per worker
Iowa	3.86	101.2	595
United States	2.05	58.2	292
Alabama	0.81	31.6	112

*U. S. Department of Agriculture Bulletin 1348.

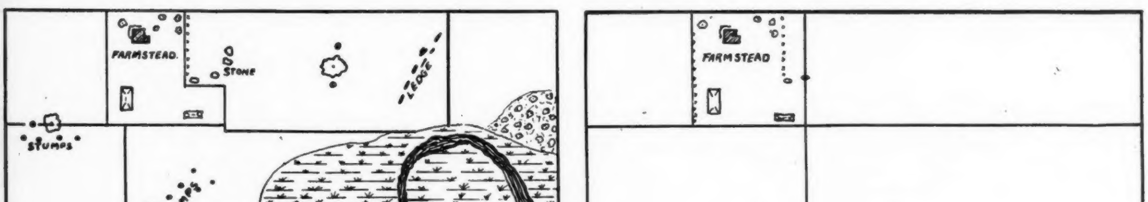
The size of farms is no longer measured solely by acres. It is rather measured by acres times the number of field operations. Forty acres of potatoes, requiring perhaps twenty operations, represents the equivalent of 800 acres once over, and may equal or exceed the power required for 200 acres of wheat with perhaps only four field operations. The potato crop probably yields double the returns.

These are some of the changes which are particularly evident as factors favoring the reclamation as a basis for efficient farm machinery operation. To repeat, it is not a question of whether or not we need more land under cultivation, but rather which land we need. Naturally, the early development of machines came on the open prairie, but recently the trend is toward the application of machinery to more accessible and older-developed sections.

In Lancaster County, Pennsylvania, famous for its advanced development of agriculture, a study by the agricultural engineering department of Pennsylvania State College reveals that 24 per cent of the farms have stones or rock ledges in fields obstructing the use of machinery. In several other counties studied, the situation was even worse with percentages as high as 64 per cent. Further study and experiment in Pennsylvania included complete reclamation of such fields and records of crop production. On a 40-acre unit a corn crop was completely produced with a general-purpose tractor at a cost of 6.65 man-hours per acre where reclamation costs averaged approximately $15.00 per acre. The number of tractors in Pennsylvania increased 550 per cent from 1920 to 1929. Just another example is Marathon County, Wisconsin, where farmers used over two million pounds of explosives in the past ten years to make possible straight, square-cornered, open fields, suitable for the use of power machines.

Great work in drainage and soil erosion, all in the direction of making fields more suitable to modern methods, show the importance of these phases of reclamation.

Just what land reclamation means in relation to machinery operation is easily realized from the accompanying farm map. The original farm with stumps, stones, rock ledges, trees in the fields, hedges, bad fence rows, and a meandering stream causing swampy areas, represents an extreme case to be sure, but such conditions are frequent even in the finest agricultural sections. Reclamation engineering and farm planning can easily make this a more efficient farm. In its original condition, modern machinery is almost out of the question. Reclamation costs are comparatively small to make this an economical farm layout. Removal of a few stumps, stones, and rock ledges would cost perhaps $10.00 to $15.00 per acre for the individual fields involved. Straightening the bow in the creek would have a profound effect on the entire farm. Whether additional acres are needed for cultivation will determine the use of any newly subdued land. Improvement may be in the direction of a timber crop. Small fields or patches must give way to larger, straight, open, efficiently operated fields where low cost crops may be grown. This will be a real factor in the development of agriculture during the next twenty-five years.



(Left) Hundreds of thousands of farms like this, with small, obstructed fields, require hand methods of operation. (Right) The same farm reclaimed for efficient operation. Stumps, boulders and rock ledges have been removed and the stream straightened

The Status of Soil Erosion Control

By C. E. Ramser[1]

DURING recent years there has developed a more general realization of the serious menace uncontrolled soil erosion presents to agriculture throughout a large part of the United States. Investigations have brought out the fact that depleted soil fertility is more frequently the result of erosion than of overcropping, and that satisfactory methods of controlling erosion on cultivated land will have to be developed if large areas are not to become unproductive.

Terracing and soil-saving dams have been generally accepted as the most effective means so far devised for controlling erosion on cultivated land. During 1930 more than 2,500,000 acres were terraced and the practice is spreading rapidly. There is a wide difference of opinion regarding terrace design, particularly in different sections of the country, due largely to differences in soil, topography, crops, rainfall, agricultural practices and climatic conditions. The results obtained from the terracing already done indicate the need of a thorough study of all of the problems connected with erosion control, with the aim of developing the most effective and economical methods and equipment for such work.

Millions of acres of land throughout the country today are satisfactorily terraced from the standpoint of preventing gullies and severe sheet erosion. The question is, Are they economically terraced? Could the same results be obtained with terraces spaced farther apart or having smaller terrace embankments, thus reducing the cost of construction? Are the terraces in some instances, where the grade is steep, carrying off too much of the soil from the field, or, where the grade is level, is an effort being made to conserve all of the soil at too great a cost resulting from a closer spacing of terraces? Cannot improvements be made in present terracing machinery, or new machinery be developed, that will greatly reduce the cost of construction? Can the cost of farming terraced land be reduced by making changes in the cross-sectional design of terraces or by improvements in farming methods and in farm machinery? These are some of the questions it is hoped to answer.

The experiment farms have not been in operation a sufficient length of time to warrant the drawing of definite conclusions regarding terrace design, but some interesting observations have been made that illustrate the type of information being obtained. For instance, it has been found that, where a terrace is built by throwing up earth from both sides, a furrow is often left along the lower side. During heavy rains this furrow fills with water which generally breaks out of the furrow at low points, resulting in concentrations of the water that cause gullies between the terraces. Where a terrace is built from the upper side only, no such furrow is left. In building terraces from both sides it is extremely important, therefore, that any furrow be leveled off so that it will not hold water.

In the Red Plains area of Texas and Oklahoma, it has been found that four or five times as much soil is carried off by a terrace with a grade of 4 inches per 100 feet, as by a terrace with a grade of 2 inches per 100 feet. This indicates the importance of giving careful consideration to the grade at which terraces are constructed.

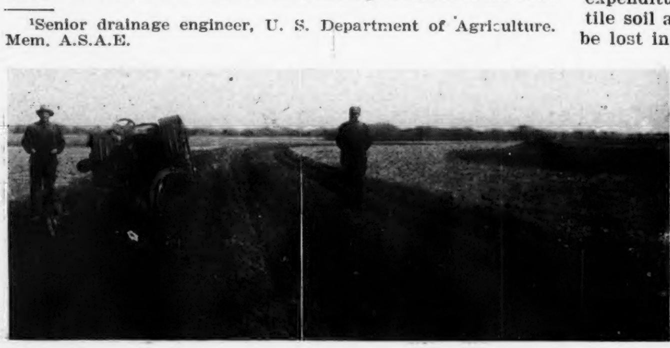
The cost per acre of constructing terraces, including the cost of scraper work necessary in building them across gullies, has varied from $3.25 on cleared land free from stumps, and with comparatively few gullies, to $14.50 on badly eroded land with numerous deep gullies. This great difference in cost illustrates the economy of protecting against erosion before it occurs. Incidentally, the area where the terraces cost $14.50 was so badly eroded that it had been abandoned.

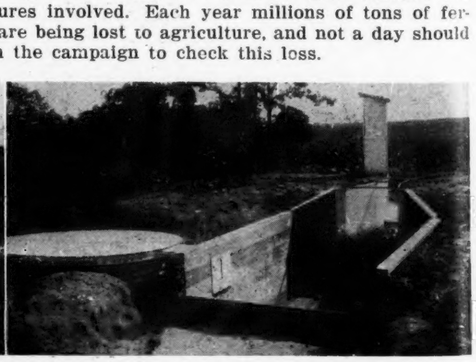
In the semi-arid regions of Oklahoma and Texas it has been found that terracing is an effective method of conserving moisture and that a material increase in crop yields can be expected when the practice is followed.

In connection with farming operations, it has been found that much of the tractor equipment now being manufactured is not sufficiently flexible to operate over terraces in a satisfactory manner. Studies have been made of the operation of several machines, and suggestions have been made to the manufacturers for improving their equipment. The manufacturers realize that much of the agricultural land in the United States must be terraced sooner or later, and that their equipment must eventually be designed to operate successfully over terraced land.

The results obtained to date from the investigations under way are not conclusive, but they do indicate that worth-while improvements in methods of erosion control may be developed over a period of years. In the meantime, what are we going to do about controlling soil erosion? It is proceeding at an alarming rate. Are we going to wait years for the research work to develop the ultimate control methods, or are we going to apply the best methods of control known today as industriously as possible, taking advantage of the results obtained by the reseach workers as rapidly as they become available? We cannot advocate too strongly the desirability of proceeding as rapidly as possible with the construction of terrace systems built in accordance with the recommendations contained in existing bulletins on the subject as issued by the federal department of agriculture and state institutions. Terraces so built may not be as cheap as those devised later on, but we know that under ordinary conditions they will be satisfactory and that the benefits resulting from their construction will more than warrant the expenditures involved. Each year millions of tons of fertile soil are being lost to agriculture, and not a day should be lost in the campaign to check this loss.

[1]Senior drainage engineer, U. S. Department of Agriculture. Mem. A.S.A.E.





(Left) Building a Mangum terrace 25 feet wide and 15 inches high with one of the types of steel terrace graders widely used in constructing terraces. (Left) The Ramser silt-measuring device developed for use in measuring run-off and silt losses from terraced areas

Engineering Achievements in Land Clearing

By Geo. R. Boyd[1]

IN THE pursuit of knowledge engineers have covered a wide range of possibilities concerning such seemingly simple matters as clearing land of brush, trees, stumps and stones. Ever since primitive man was driven to cultivate the ground, land clearing has been one of the important labors of mankind. The grubbing hoe is probably the most widely known, if not the most popular, tool in the world.

Since land clearing is so old, it might be thought that every possibility in the way of methods had been exhausted centuries ago; on the contrary, the subject constantly presents new problems. Within the last ten years a rather comprehensive study of land-clearing methods has been made in England where the farm lands have been highly developed for many hundreds of years. Continually fields are being allowed to grow up to timber, and new lands to take their places are being cleared; new sources of power and new inventions in many lines of endeavor provide new possibilities in land clearing. Nor are activities confined to any one section, for land-clearing engineers have found work to do in each of our agricultural states.

Detailed studies have been made of the use of explosives, mechanical devices, and fire in destroying stumps; of fire, livestock, and chemicals in destroying brush; and of poisons in killing and hastening the decay of trees. Investigational work in explosives was stimulated, through a period of years, by the distribution of the surplus war explosives by the federal department of agriculture acting in cooperation with various state agencies. The research work done in connection with this distribution, together with the increased interest developed in the use of explosives for agricultural purposes, resulted in the commercial production of a number of low-density explosives which are much more efficient in stump blasting than the explosives formerly used.

Commendable progress has been made, in recent years, in the perfecting of mechanical devices used for pulling stumps. Horse-power pullers have reached a high state of perfection, and tripod pullers, which were so commonly used in earlier times, have practically been abandoned in favor of the more efficient type which exerts its pull in a horizontal direction. Land-clearing engineers have kept step with the development of the gas engine and the tractor, for there are a number of successful pullers which use these sources of power. Much inventive ability has been expended on large land-clearing machines and many of them have been mechanically successful, though not always financially so since there is only a limited demand for large-scale clearing devices.

The study of fire as a means of stump removal and destruction has resulted in the development of a number of methods of controlling the heat and draft, such as the Zysset burner in Oregon, the Miller burner in Washington, and the Stirniman "stove" in California, all of which give excellent results under certain conditions.

Investigations of methods of removing field stones and boulders, carried on in Minnesota and Pennsylvania, have resulted in better methods of handling and have indicated the possibility of perfecting machines for this purpose.

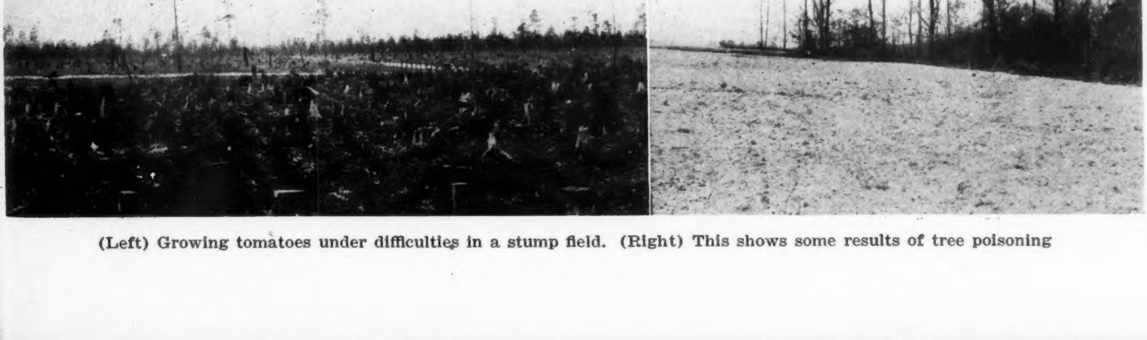
Studies of the use of broadcast burning in removing brush have brought out the fact that such burning is not only economical but that it can be effectively controlled; they have also indicated that the burning of brush, brush piles, or stump piles has no harmful effect either on the soil or on crop production.

Studies in the use of poisons to kill and hasten the decay of trees have brought out some new facts regarding the effectiveness of various poisons, time of poisoning, and reactions of various species to poisons.

Chronologically, the first broad field for the use of basic information as to methods and costs of land clearing is in connection with land classification according to utility. This movement aims to so clearly establish the facts regarding land that an intelligent person can determine whether or not a specific tract is suited to his purpose. Land classification is being adopted and put into practice by both state and federal governmental agencies. Any such survey must include a resume' of the probable costs of putting potential agricultural land into cultivation. The cost of preparing the land for economical crop production may be and, in many cases, is the determining factor as to the present suitability of the land for agriculture. Thus the basic information as to methods and costs of removing stone is applied in determining what lands may be considered too stony for profitable agriculture.

The next use of basic land-clearing data, as derived from research, comes in connection with the actual settlement of new land. In spite of recurring depressions, new farms are being developed at all times. Not only that, but our considerable unsettled areas that are potentially suitable for agriculture will some day be needed and their settlement then will be a pressing problem. In anticipation of that day, adequate plans covering the engineering features of a well-considered land-settlement procedure should be developed. Specific problems already encountered, but as yet largely unsolved, include such questions as whether a settler has a better chance on a "ready-made" farm, cleared and developed, or on one entirely undeveloped. There is a present need for a detailed management program for farms that are in process of development—a program that will make each farm a

[1]Senior drainage engineer, division of agricultural engineering, bureau of public roads, U. S. Department of Agriculture. Mem. A.S.A.E.



(Left) Growing tomatoes under difficulties in a stump field. (Right) This shows some results of tree poisoning

balanced unit as to crops, livestock, buildings, machinery, and cleared acres, each in its economical relation to the whole, during each year while the farm is being developed.

The last and most important field for the application of the basic land-clearing data is found in the better development of farms already under cultivation. This is the "raison d' etre" of land-clearing investigational work because in it lies the greatest opportunity for usefulness. No one questions the desirability of reducing the costs of producing crops. Indeed, there are those who say that it is the best solution of our agricultural problem, and few will disagree with the statement that efficient use of modern farm machinery is the most promising method of reducing such costs.

However, the most enthusiastic advocate of farm machinery does not insist that it can be used effectively in a stump field. Probably the most efficient equipment for plowing in a stump field is a mule and a Georgia stock plow, but even with this outfit one-third of the time of plowing can be saved by removing the stumps. As the size of the equipment is increased, the percentage of time lost due to the presence of stumps mounts rapidly. The Pennsylvania investigations showed that the presence of stones in a field increased the cost of plowing with a tractor by as much as $1.64 per acre.

The first requirement for efficient operation is a field clear of stumps and stones. The next is a field large enough and so shaped that little time is lost in turning; and here again is the need for land clearing since, in many sections of the country, the fields are small, irregular in shape, bounded by irregular pieces of woods, and cut up by hedges. A recent survey of 35 farms in the Piedmont section of North Carolina showed the average size of the fields to be 1.4 acres. Another study in southern Minnesota, in a highly developed section, showed that, on every one of the 20 farms surveyed, improvements that would result in more economical tillage could be made in the layout of the fields.

Finally, each individual farm should be an efficient unit, that is, there should be enough large and regular fields, free of stumps and stones, to support a balanced crop-rotation system. On some farms this may mean the clearing of additional lands, but the advantages of such a course, from the standpoint of the individual farmer, cannot be denied.

That, in fact, just about sums up the aim and purpose of land clearing, namely, to put the individual farms in the physical condition that will permit the most efficient agriculture.

Engineered Farm Structures

By W. G. Kaiser[1]

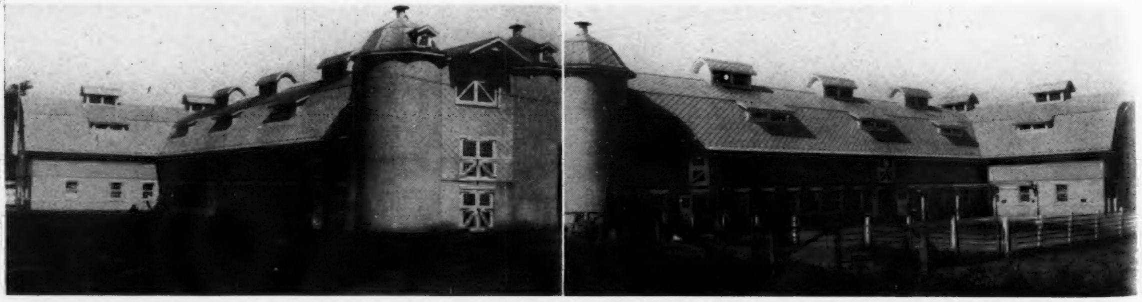
WHEN mention is made of the rate of development in farm structures I am reminded of an item which appeared in a recent farm press release of the National Association of Farm Equipment Manufacturers. It related how archeologists, digging into the ruins of a city that flourished 6,000 years or more ago, unearthed a stone tablet on which was carved a scene depicting one of the ancients milking a cow. He was working from the rear with the animal's tail over his head. Until the advent of the modern milking machine, it appears, the only improvement made in milking over a period of sixty centuries was for the milker to move quarter-way around the cow and approach her from the starboard rather than from the stern.

In a measure, progress in the development of farm structures has been quite analogous to the development in methods of milking. Real progress was achieved in each case only when engineering entered the picture. Although we are sometimes inclined to be dissatisfied with the rate of progress, there has been considerable advance made, nevertheless, in providing suitable shelter for livestock and for housing farm products. Engineering has played and is playing a leading part in this development. "Engineering is the science of controlling the forces and utilizing the materials of nature for the benefit of man and the art of organizing and directing human activities in connection therewith." Let's analyze this definition of engineering and see what engineering has done for farm structures.

It can safely be assumed that man is attempting to benefit himself when he provides improved housing for his livestock and his crops. In assembling and fabricating the materials with which modern structures are built the forces and materials of nature are being utilized in a marked degree. Whole mountains are blasted out, pulverized to indescribable fineness, subjected to temperatures which would convert steel into a fluid mass and then reground to an inpalpable powder in order to produce the cementing agent for constructing the foundation walls and floors for farm buildings and frequently for building the walls of the superstructure. Every step in the manufacture of cement is an engineering process utilizing the materials and the forces of nature.

In like manner man has scooped out great craters in the earth's crust to obtain suitable clays for molding into the brick and building tile with which we are all familiar. Man has also turned to a bountiful nature for the timber which is cut into lumber with its myriad of uses. The metal that is used in the hardware as well as in the various accessories and equipment and the glass in the

[1]Agricultural engineer, Portland Cement Association. Mem. A.S.A.E.



Two views of a typical engineered farm building. This dairy barn on the Springfield State Hospital farm, near Sykesville, Maryland, is modern in every detail

In the era which we are entering guess work will be largely replaced with facts, and out of this development will come changes in building construction which may be even more revolutionary than the changes from hand to machine method of milking

windows came originally from nature's vast storehouse. Surely man has been generous in the utilization of the materials of nature for the construction of farm buildings.

In harnessing the forces of nature man does not stop with the processing of the construction materials, but his ingenuity is utilizing the kinetic energy of heat and air currents to ventilate the buildings, exhausting the vitiated air and pulling in new supplies of fresh air. In many ways the same force which causes apples to fall to the ground is serving to help transport feed supplies or remove litter. Space does not permit mention of all the many important ways in which engineering is being applied in the construction and operation of farm structures. Truly progress in this field has been little short of phenomenal.

Despite this amazing progress, there is yet much to be done in applying engineering principles in farm building construction and operation. Many present farm building plans are based on preferences or prejudices, rather than on a consideration of the basic factors which should govern their design. How else can we account for the fact that adjoining states with practically identical climatic conditions will recommend radically different types of buildings. The many designs for poultry houses is a striking example of this. And until we know more about the fundamental requirements of the various farm structures we will continue to design on a hit-or-miss basis, and will try to fit our buildings to certain more or less arbitrary patterns. For instance, in designing some animal shelters we attempt to provide a certain minimum of air space for each animal housed. In doing this we go to the expense of enclosing air when there is an unlimited amount of purer air on the outside which is free for the taking. Study the layout of the modern dairy barn and you will find more space provided for the occasional use of the herdsman than for the animals which occupy the barn. Likewise, examine some of the plans which are advocated for hog houses and poultry houses; head room for the attendant is provided at the cost of comfort for the animals and birds quartered therein. Other equally glaring inconsistencies in farm building designs could be pointed out.

Despite the foregoing remarks, I have a great deal of faith in what the future holds for farm building development. Agricultural engineers are freeing themselves from the entanglements of the hit-or-miss way of doing things and are conducting a searching analysis into the underlying factors which must precede an intelligent handling of the problem.

Then, too, there is the economic side to consider with benefits to be derived that are commensurate with the costs of construction and equipment. In reckoning costs, a true basis of value takes into account the serviceability and the durability of the structure. In a number of instances economists have been inadvertently guilty of giving the impression that farm building costs are too high and suggest the cheapening of construction as a means to lowering operating costs. The error in this line of reasoning lies in the false premise that farm buildings are a necessary evil. Rather they should be regarded as essential equipment for increasing production or lowering production costs. The real value of a structure should be based on its annual returns. Unfortunately these returns are rather intangible, and, as a consequence, there has been much loose thinking, or lack of thinking, in considering farm buildings from the standpoint of economy.

In the era which we are entering guess work will be largely replaced with facts, and out of this development will come changes in building construction which may be even more revolutionary than the changes from hand to machine methods of milking.

A modern engineered farmstead. This barn with good stock and management will probably not only pay for itself but for the modern farm house as well

The Housing Factor in Milk Production

By J. L. Strahan[1]

PERHAPS nothing has contributed more in recent years to the development of adequate housing for dairy cattle than the insistence of the public, as expressed in regulatory municipal legislation, upon dairy products being of high grade. Discovery of the sensitiveness of milk as a medium for the growth and dissemination of pathogenic bacteria has resulted in the enforcement of regulations designed to protect it at its source—in the stable. While this has seemed to work a hardship on many producers, in reality it has been a very good thing for the industry as a whole. Stable conditions conducive to clean production have also, when properly considered, been the means of reducing operation costs and increasing volume of production per cow, both of which result in more profit for the producer. And in our country today a reasonable profit is an index of survival value.

An example will serve to show how this has come about. High bacteria counts are more frequently found in milk from dusty stables. A favorite regulation, therefore, has been that stable walls and ceilings shall be smooth and free from dust. This lead some to ceil these surfaces on the inside. In cold climates such ceiled surfaces were frequently wet with moisture condensed out of the stable air, causing rapid depreciation of the materials used, and leading to a study of means for preventing it. Hence ventilation. I do not mean to suggest that this is the only or even the most important reason for the many studies that have been made and that are being made now on this important phase of the housing problem, but it has had its effect.

Another important factor has been the fight against tuberculosis, also largely a public measure. And what are we finding? Healthy air conditions do, in a large measure, protect the cows from disease and the milk from contamination. In addition an important, favorable influence on volume and cost of production is beginning to show up as a result of the increased control over stable temperature made possible by the proper manipulation of a ventilation system. Thus, a program that started out to catch bacteria for the good of the general public bids fair to end up by catching dollars for the good of the dairyman.

Further research in this field is clearly needed. Economic studies paralleling engineering studies will emphasize the significance of their results and speed up practical applications tremendously.

As an example of an engineering study showing the relation between building design, ventilation and temperature control, A. W. Clyde, of the Iowa State College, recently reported[2] that the application of insulating material to the ceiling of a stable reduced the heat loss per cow per hour per degree of temperature difference between stable and outside air from 41.5 to 27.8 Btu. The saving of this amount of heat in a stable housing over sixty cows enabled him to improve the condition of the air and at the same time to reduce the temperature variations a very considerable amount. The temperature difference he was able to maintain with sixty cows was 12 degrees (Fahrenheit) greater than he could hold with sixty-three cows before the insulation was applied.

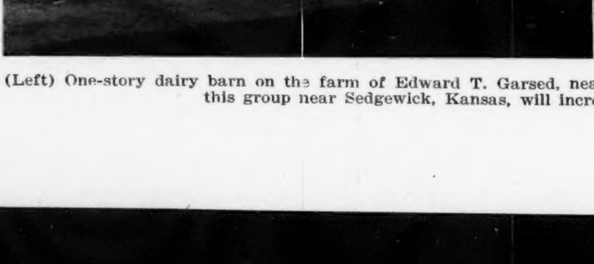
While he does not claim to have solved all the problems involved in the control of temperature as related to building design and construction, his work does indicate a number of very profitable lines of engineering research. But, from the standpoint of the milk producer, another study should accompany it. The object of this second study should be to observe and to evaluate the effect of temperature variations on milk production, both as to volume per cow and cost per 100 pounds. A well-coordinated cooperative project, including both the engineering and the economic phases of the problem, would produce results of immeasurable value, results that would find ready application on dairy farms the country over.

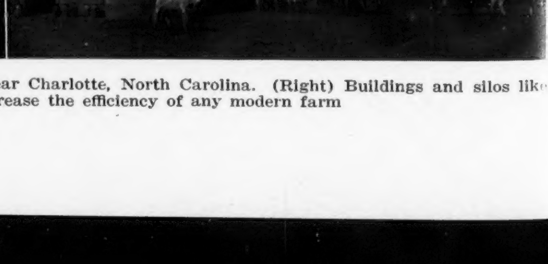
Practically every factor in the milk industry is affected in one way or another by housing conditions. Health of the stock, and hence depreciation of the herd, is largely dependent on stable air conditions. These are functions of the materials used in the construction of the building, the design and manipulation of the ventilating system, and to a certain extent, of the arrangement of the stable as it affects cleanliness. Efficiency in feeding is dependent upon floor construction, type of equipment in use and stable temperature. Labor economy depends upon the organization of the buildings in the group, interior stable arrangement, and the use of adequate machinery and equipment. And lastly, the quality of the finished product is a definite function of the handling methods, which are affected by building arrangement, organization and details of construction.

There can be no question as to the existence of these relations. The reason they have not been recognized more generally in practice is because, as yet, very few studies have been completed and popularized that clearly and definitely state their value in terms of money. And herein undoubtedly lies the field for research that will yield the greatest returns in benefits to American dairymen in the next decade.

[1]Consulting agricultural engineer. Mem. A.S.A.E.

[2]"Barn Ventilation with Electric Fans," by A. W. Clyde, AGRICULTURAL ENGINEERING, Vol. 12, No. 1 (January, 1931).





(Left) One-story dairy barn on the farm of Edward T. Garsed, near Charlotte, North Carolina. (Right) Buildings and silos like this group near Sedgewick, Kansas, will increase the efficiency of any modern farm

The Economics of Farm Buildings

By H. B. White[1]

THE economist with a conservative program has been well to the front in the agricultural picture in the past few years, and has taken away some of the attention that might have well been directed to developing a more widespread desire and appreciation for better farm homes and better farm buildings. It is not the intention of the foregoing statement to belittle the importance of making the farm business measure up to the established prin ciples of economics where the operations carried on will pay a return for the time and money invested. It is rather that attention may be focused upon engineering practices, which when applied to farm buildings will reward the farmer for his intelligent effort.

The development of civilization to its present stage of enlightenment has been accomplished mainly in the north temperate zone. This advance has been due chiefly to the ability of man to overcome the severity of the winter storms by providing adequate shelter for his animals and himself. In erecting shelter it is desirable that proper attention be given to the arrangement of buildings, as well as planning, so that there may be comfort for both man and beast, and convenience in performing routine work without undue loss of time.

The buildings on a well-developed farm represent about one-fifth of the farmer's investment and are worthy of more attention and study than they usually receive. Good buildings add to the selling value if they are not extravagantly built. Well-planned buildings save labor and make the work more pleasant.

The farm may be considered as a manufacturing establishment, the fields furnishing the raw materials and the buildings serving as the plant where beef, pork, mutton, chickens, milk, butter, eggs, etc., are produced. There is often great loss if the buildings are not adequate to shelter the livestock and feed supplies. Young animals will perish in unfavorable weather, and farm machinery depreciates rapidly if poorly sheltered. Milk will be more healthful if produced under sanitary conditions. The supply will be more abundant if animals are comfortably housed. Highly productive cows will pay for more expensive shelter than will scrub animals. The cost of farm labor may warrant the installation of equipment that will save additional help and thus reduce expense. Such equipment as drinking cups for a dairy barn should and often does increase the production and return a profit to the owner. It may be said of such improvements that, even though the farmer does not buy them, he sometimes pays for them by reduced production.

The health and happiness of the occupants of a farm home will be greatly increased in a well-planned modern house. Anyone who has camped under primitive conditions and then returned to a modern, conveniently arranged and well-equipped house quickly realizes the benefit of modern plumbing and electric service. There is a growing appreciation of the importance of having good homes with conveniences and luxuries as much as one can afford. Food, clothing and shelter do not need to be as simple as when all the labor was performed by the unaided hands. The food can be more varied and palatable, the clothing more comfortable and attractive than when made from the skins of animals secured by bow or spear. The shelter can be more than a tent or cave. It can have more of comfort and attractiveness. By the division of labor those that like to plan, manufacture and build have made possible better homes for everyone than would be possible with a self-sufficient family unit in society.

With all the knowledge of the industries striving to produce materials that will make living conditions more comfortable and profitable, it is important that agriculture adopt all those methods, equipment and materials that will make farming more economical and satisfactory.

We build better barns because they cheapen production and are also cheaper buildings when their length of life is considered. Dr. Eckles of the Minnesota agricultural experiment station states that "better barns mean cheaper production," and points out that the nearer the conditions of early summer are maintained in the shelter, the higher the production of the dairy herd; "a cow housed in a dark barn surrounded by foul air with her head fast in a rigid stanchion and her body more or less filthy is as far from summer conditions as her milk production is below that of early summer."

A survey made by the agricultural engineering and farm management departments of the University of Missouri shows that the farmers with the highest present worth in farm buildings showed the most efficient use of labor. In the production of milk it was shown that only 5.79 per cent of the cost is in buildings. The items are interest, 5.64 per cent; veterinary, 0.67 per cent; pasture, 9.08 per cent; roughage, 10.94 per cent; concentrates, 67.86 per cent; and buildings, 5.79 per cent. It is very evident that, if farmers were to economize in production, it would not help very much, even if the building costs were cut in half.

A recent survey by the American Society of Agricultural Engineers shows that farmers believe that a barn can cost per animal equal to the value of the animals. All data collected by various studies shows that good cows are the only profitable ones. A good cow can pay for a good shelter, while a poor cow or boarder should help pay for a slaughter house only.

The farm produce destroyed by rats is estimated at nearly a quarter of a million dollars per year. Fire losses in one year equal a like amount. It would seem a wise policy to avoid a part of this loss, and at the same time prevent a loss in quality of grain, corn and roots because of inferior shelter. It is well known that saving waste makes profit.

There is a desire on the part of the agricultural engineers to emphasize the importance of suitable farm buildings. A study made by the author of Wisconsin dairy

[1]Division of agricultural engineering, University of Minnesota. Mem. A.S.A.E.

A set of modern, engineered farm buildings in Minnesota

barns brought out the wide range in length of route traveled in doing the chores in caring for a dairy herd.

In barns costing $200 per stall the chore routes per cow for feeding hay, silage and grain and the removal of the milk and manure from the barn ranged from 20.4 to 55.3 feet. The difference multiplied by the average number of cows per barn, which was 27, shows that 672 feet were traveled extra twice a day, or one-fourth mile per day. A master farmer has stated to the agricultural engineers that it is not economical to hire a man to be a pedestrian while doing chores. Every 7.2 feet that has to be walked twice a day equals a mile per year.

The need of efficiency on the farm has been carried to a very splendid climax on the Walker-Gordon Farms at Plainsboro, New Jersey, where the cows are brought through lanes to a milker where they are washed, cleaned, dried and milked while riding around on a 50-stall merry-go-round. Fifteen hundred cows are kept and can be milked in 6¼ hours.

Modern industrial methods will be adopted in agriculture as fast as they can be made economically suitable. In fact, agriculture has many opportunities for dropping primitive methods and advancing by the acceptance of engineered methods.

The Status of Farm Structures Research

By Henry Giese[1]

A RESEARCH program is a logical outgrowth of a recognized need for facts. The progress of research effort on problems relating to farm structures has reflected an increasing appreciation of the influence which the structure exerts upon economic production or conservation.

In attempting to assist in the building of farm structures, the agricultural engineer has found himself handicapped by a lack of adequate information both as to the conditions which should be maintained for efficient farm housing and the proper use of materials in establishing these conditions. Since the farmer cannot efficiently conduct his own researches and the professional architect has not found the farm field attractive, the responsibility for farm structures research lies largely with the agricultural engineers in state and federal research organizations. These men have taken their responsibility seriously, although limited resources both as regards personnel and funds have curtailed productiveness.

Many farm structures problems are complex and require, for their satisfactory solution, the efforts of more than one specialist. The engineer can often render valuable assistance in solving those problems relating to housing requirements which may not be strictly engineering in character, but which are essential to adequate design. Housing problems are regional or national, and not local in their significance.

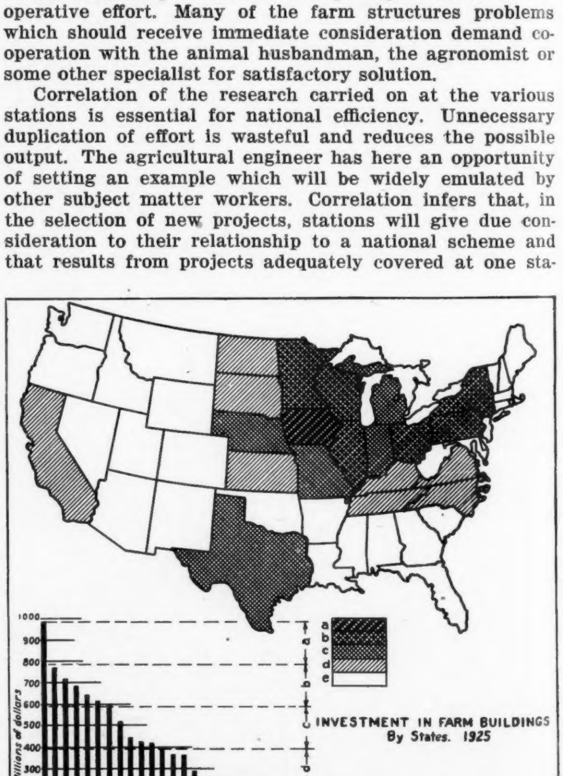
The American Society of Agricultural Engineers has been actively concerned with these problems. A committee on research development appointed in 1927 compiled lists of available publications, research in progress and suggested research problems, and reported the existing situation at a meeting of the Structures Division of the Society in December of that year. In December 1928 formal action was taken by the Structures Division requesting the Secretary of Agriculture to make a survey of the situation as regards farm structures research and to prepare a plan for a national program.

This survey conducted during 1929-30 was sponsored by the Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture, and the author was appointed director to work with an advisory council composed of representatives from a number of educational and commercial organizations which had shown a definite interest in the development of farm structures. An attempt was made to find not only what researches were being carried on or had been completed, but also what problems should be studied and what policy or organization would give reasonable assurance of a more comprehensive research program and better articulation of the activities of the various state experiment stations in the field of farm structures research.

Five states reported activity in the preparation of farm building plans; nine were conducting ventilation and temperature control studies; ten were investigating the storage of crops and seven had projects relating to the use of materials. One station was studying the economic value of farm buildings. Twenty-eight states reported no research on farm structures problems. On the whole it appeared that comparatively little research was in progress, that much unnecessary duplication existed due largely to lack of information regarding what was going on elsewhere, and that some projects were not well organized or supported. It also seemed to the advisory council that certain conditions would contribute to greater progress and coverage in farm structures research.

The first of these relates to organization. Cooperation on involved problems should be encouraged. The human tendency is to attack problems which can be completed by the individual, thus avoiding the complications and misunderstandings which are frequently incident to cooperative effort. Many of the farm structures problems which should receive immediate consideration demand cooperation with the animal husbandman, the agronomist or some other specialist for satisfactory solution.

Correlation of the research carried on at the various stations is essential for national efficiency. Unnecessary duplication of effort is wasteful and reduces the possible output. The agricultural engineer has here an opportunity of setting an example which will be widely emulated by other subject matter workers. Correlation infers that, in the selection of new projects, stations will give due consideration to their relationship to a national scheme and that results from projects adequately covered at one sta-



[1]Professor of agricultural engineering, Iowa State College. Mem. A.S.A.E.

tion will be adapted and applied by all other states concerned. Several of the stations are now carrying more projects than can be conducted satisfactorily by the personnel and funds available. Specialization in limited fields by one worker or station will improve the quality of research.

A program of this type requires leadership and can be built only upon confidence and mutual understanding. The Division of Farm Structures in the new Bureau of Agricultural Engineering has a definite responsibility and a remarkable opportunity in organizing farm structures research effort, and thus assuring a better and more comprehensive program. Federal assistance can in many cases supplement the effort of the states on interstate or regional problems, to the mutual advantage of both cooperators.

A more logical analysis and attack would materially assist in securing the necessary personnel and funds for the conduct of research. Efficiency in production frequently results from economic depression. The justification of a farm service building lies in its ability to function as an efficient tool in an industry and to return to its owner a maximum income in consideration of the investment it represents. Whether it be an animal shelter, a crop storage or a building for housing equipment, its success depends upon its ability to provide the conditions required by the product housed within it. Many of these conditions are not definitely known. When they are determined, the engineer is in a better position to study the use of materials to provide the desirable conditions efficiently and economically. Space here does not permit the listing of specific problems. A large number are given in the final report of the survey. National emphasis should be placed upon one or two types of housing at a time, although other projects will be carried collaterally as local conditions seem to justify. The advisory council has emphasized the farm house and the housing of the dairy cow. The first was chosen because of its relation to living standards and the well-being of the American farmer; the second because of its national character, the influence upon public health and its economic significance.

The agricultural engineer has made a worthy contribution to the science of farm buildings considering the limited resources which have been at his disposal, although popular demand for plans and the lack of facilities for carrying on research have caused him to give attention to structural problems before the service requirements were determined. The future of farm structures research depends very largely upon national organization and the careful consideration of buildings as tools of an industry. National correlation will result in a better coverage from a given budget, greater specialization and a higher quality of research effort and a better understanding among workers in this field. Industrial research at publicly supported institutions should be encouraged and specific attention given to the study of the various building materials, their proper use and specification when used in farm buildings. The ultimate goal of this program should be a better understanding of the requirements of farm structures and the adoption of practices which will enable the American farmer to lower his production costs, preserve his products in a more marketable condition, and raise his living standards.

Engineering's Contribution to the Farm Home

By Deane G. Carter[1]

THE farm house represents the largest single item in the investment in farm buildings, and covers a wider range of size, materials, utilities and personal taste than any other structure.

The differences in the design of rural and urban homes are not essentially those of quality or facilities, but differences due to specifically rural needs or requirements. Under favorable conditions of location and finance, it is possible to provide the farm home with every engineering and architectural feature available to the urban residence. The extension of power line electricity; the design of the farm light and power plant; the development of power water systems, sewage disposal methods, and compressed or artificial gas equipment; studies in the use and application of structural materials; farm home planning; standards of farm housing; and cost analyses—all have aided in developing the farm home to a standard comparable with the urban home. However, there are numerous factors involved in the farm home that require further research.

[1]Professor of agricultural engineering, University of Arkansas. Mem. A.S.A.E.

This house has no unusual design features but is superior to the typical tenant house, providing sufficient space and some utilities

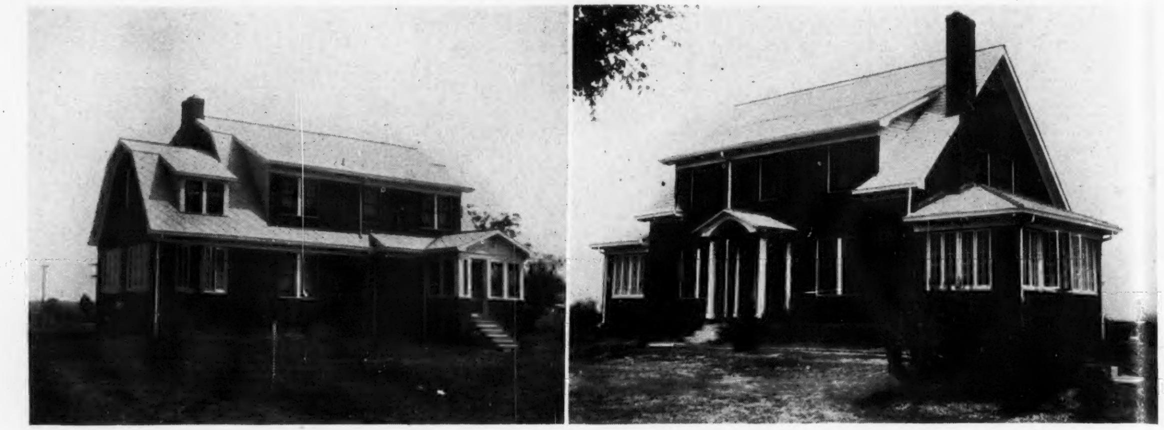
The solution of the problems of the farm home involves the coordinated activities of architecture, agricultural engineering, and home economics. It is the function of research in these fields to establish farm home requirements and standards in a scientific manner.

Because of the many interests represented in the farm home, it is inevitable that the research studies have dealt with a wide variety of problems.

Increasing interest in the farm home in the past few years has led to numerous studies that are now in process of analysis, or have been reported only within recent months. The object of this paper is to present examples of the agricultural engineering and related studies designed to develop and establish standards for the farm home. Within the limits of a single paper it is possible only to give brief mention to a few studies.

Limitations of the Problem. It is obvious that the wide range of needs due to size of family, financial conditions, location, climate, environment, and living or social standards, prevents the adoption of any single set of requirements for the farm home. A recent report by the author (Agricultural Engineering, September 1930, Vol. 11, No. 9) indicates that the specific needs of the farm family may be analyzed and classified as a basis of planning and design. As a result of studies at the Arkansas agricultural experiment station, it appears that there are certain basic factors differentiating the farm home from the urban home. Briefly these factors are as follows:

1. The farm home is a part of the real estate to which it is attached, and usually represents a minor part of the whole farm investment. Therefore, it is often impossible to take account of family needs, except in general terms.



Farm homes should be designed to meet the rural requirements in general and the needs and standards of our farm and family in particular. Where there is no cost limitation thoroughly modern farm homes are no different from urban homes in quality and equipment. Increasing efficiency of farm production will tend to remove the usual cost limitation

2. The farm house, being fixed, is throughout its useful life occupied by a succession of families, or by one family through a series of changing requirements.

3. The equipment and utilities for health, sanitation, comfort and labor saving must be the individual responsibility of the owner, for due to the isolated location these facilities cannot be provided through group action or by public-utility agencies.

4. There is an extreme range in the character, living standards, financial ability and personal tastes of families on farms, demanding wide variations in the quality of housing.

5. In perhaps a majority of cases the cost of the house and the ability to pay is the limiting factor in farm housing.

Time Women Work. A logical procedure in the effort to effect a saving in time cost is to determine first the normal time requirement for housekeeping. Sybil L. Smith, reporting work done by the Oregon, Washington, and Rhode Island stations, and the U. S. D. A. Bureau of Home Economics (Report of the Agricultural Experiment Stations 1929) finds that the normal time requirement for all housekeeping duties is approximately 53 hours per week. About 25 hours per week are devoted to food activities; nine hours to the care of the house; twelve hours to clothing and textiles; three to four hours to care of the family, and two hours to management activities.

Analyses of specific duties indicates that three hours and ten minutes were expended in carrying water for all household purposes (Nebraska station). Time required for the care of ordinary kerosene lamps amounted to 50 minutes a week. Maud Wilson (Oregon station) found the laundry time costs in 311 households average six hours seventeen minutes a week.

Equipment for Labor Saving. Major projects in agricultural engineering, involving equipment for the household include studies in rural electrification, farm lighting plants, water supply systems, laundry equipment, cooking equipment, electric refrigeration, and others. Space permits of a report on only two recent studies.

Ackerman (New Hampshire) reports on costs of electric laundry equipment as follows: Washing machines consumed an average of 30 kwh per year, at a cost of \$2.94; flatirons, 83 kwh per year, at a cost of \$3.28, and electric ironing machines, 109 kwh per year, at a cast of \$4.51.

Miriam Rapp (Purdue) studied the efficiency of farm fuels used in Indiana. The thermal efficiency of top burners of typical cooking stoves was found to be as follows: Coal, 5.3 per cent; kerosene, 33.5 per cent; gasoline, 40.3 per cent; artificial gas, 50.9 per cent, and electricity, 83.3 per cent.

Sanitation Studies. Work at the New Jersey, West Virginia, Kansas, Illinois, and other experiment stations, has dealt with the problem of sanitation, septic tank design, biology of sewage disposal, and quality of farm water supply. The U. S. Public Health Service has reported in detail on phases of rural sanitation. The most recent publication on septic-tank sewage disposal is from the Illinois station (Station Bulletin 304). Their conclusions reported indicate that (1) the septic tank should be so designed as to make an average allowance for sewage flow of 18 to 25 gallons per person per day, depending on the size of the family, (2) ordinarily it is not practical to build a tank smaller than the size required for 7 people, (3) in a single chamber tank a 72-hour retention period should be provided (in a two-chamber tank a 72-hour retention period should be provided in the first chamber, and an additional 36-hour retention in the second chamber, capacities being in the ratio of two to one), (4) when properly designed the two-chamber tank is more efficient than the one-chamber tank.

Activities and Opportunities. Federal bureaus, state experiment stations, extension services, and numerous individuals and organizations are doing excellent work, not only in study and research, but in active educational work. It is possible to mention only a few specific examples: In farm house architecture — Ward, Etherton, Wichers, Brinckloe, Betts and Foster; in utilization of building materials — Long and Miller; in home economics aspects — Gray, Rapp and Wilson; in farm sewage disposal—Walker, Driftmier, Kelleher and Lehmann; in rural electrification—Kable, Hienton, Patty, Stewart, Easter, Seitz, and many others.

Among the organizations active in this work are Better Homes in America, the American Farm Bureau Federation, and several farm publications.

The agricultural engineer, as the engineering representatives in the agricultural college, experiment station, and agricultural extension service, must necessarily take an active part in the future development of the farm home.

Outstanding Needs. The continuance of research that will produce specific recommendations, the coordination of all research on the farm home by a single agency, and the development of a series of minimum standards for adequate farm living appear to be the outstanding needs in the solution of the farm home problem, from the engineering standpoint.

There is need for a more widespread application of the principles of architectural design to the farm home. There is some opportunity for the practicing architect and the semi-commercial agency in the farm house field, although much pioneering work must necessarily be done by the public service or governmental agencies.

Research in social and economic phases of the home represents a needed contribution.

The Relation of Engineering Practices to Soil Fertility

By F. A. Lyman[1]

FERTILITY is the farmer's greatest asset. Without adequate plant food elements his labor is in vain. A sand bank tilled with the most modern tools will yield no more than if stirred with a crooked stick. If the agricultural engineer is to fulfill his avowed mission of providing a higher standard of living on American farms, he must view soil fertility maintenance as a problem and a responsibility.

Fertility is the most important factor in making possible a profitable return from the tillage of the soil. It is therefore a direct measure of the value of the land. Future agricultural prosperity depends upon maintaining a full measure and balance of the elements which make up soil fertility, and agricultural engineering success is predicated upon increased profits in agriculture.

Agricultural engineering practices, marked by the rise in the use of mechanical power during the past quarter-century, have in some cases reacted harmfully to the maintenance of soil fertility. Too great emphasis has frequently been placed on the reduction of production costs through the use of power and machinery, to the exclusion of the crop-yield factor. It has been easier and more attractive to many farm operators to reduce labor and equipment costs, even at the expense of depleted fertility, than to follow out systems of farming which return greater profits at the expense of slightly greater labor throughout more months of the year. As a result, we have seen the rise of the "suitcase" farmer, who depends upon crop-farming which occupies only three or four months time per year. The power and machinery now available have made this type of farming possible, and in many cases profitable. Seldom, however, is adequate provision made in such a system of farming for the maintenance of fertility which will assure future yields in the profit-making range. In such cases, the agricultural engineer is faced with the problem and the duty of sounding a warning as to the ill results of the misuse of his handiwork.

On the whole, however, agricultural engineering developments have greatly benefitted the farm operator who has sufficient thought for the future, and the knowledge to apply them to the maintenance of the future earning power of the land.

Several important fertility practices fall directly in the province of agricultural engineering. It is almost certain that agricultural mass thinking will swing from the recent and present emphasis on the mechanical factors in reducing production costs, to the balanced program which includes the agricultural engineering phases of agronomy and animal husbandry. It is certain that no agricultural engineering program which leaves out or subordinates consideration of soil fertility can be economic.

Agricultural engineering practices relate to soil fertility from three angles. First is that of making the fertility in the soil available; preparing the land so that crops may be planted and cultivated. Second, and applicable over the widest range of conditions, perhaps, is that of utilizing to the greatest advantage the fertility which is in the soil. Third, the most important to the future, is the problem of replenishing fertility elements removed by crops, and adding to them where fertility is at present subnormal.

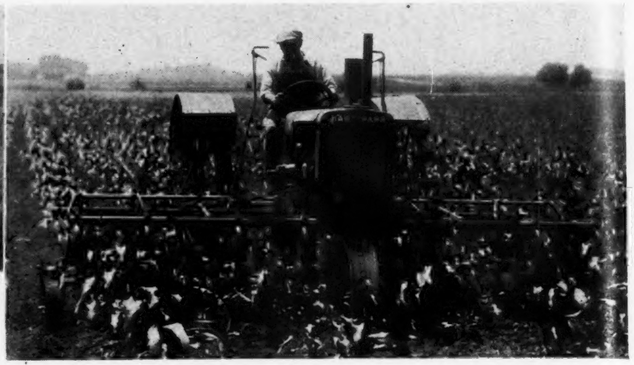
There are three agricultural engineering practices which aid in making land available for cultivation so that the fertility in the soil may be brought into use. The most recent, and the one which will probably have the greatest growth in the future, is terracing, which is practiced to prevent soil erosion and to reclaim eroded lands. Terracing is also important as a moisture conservation method, and moisture is necessary to make plant food elements available to growing crops. The counterpart of terracing, in many respects, is drainage, one of the first and most necessary of agricultural engineering practices. Drainage still has an important part to play, should present undrained, tillable lands be called into production. Irrigation has, strangely enough to the uninitiated, made drainage necessary in many cases to prevent the accumulation of undesirable and harmful mineral salts which a high water table brings into root-growing strata, poisoning the plants.

Subsoiling, too, is frequently necessary in certain soil types to break up hard layers of soil beneath the surface which prevent the transfer of moisture from subsoil to plant roots, or which prevent the accumulation of a sub-

Feeding animals in the field results in natural fertilization or returning wastes to the soil without handling. This practice is facilitated by fencing, movable shelters, and crop rotation

[1]Agricultural engineer, The Buchen Company. Assoc. Mem. A.S.A.E.

Careful preparation of the seedbed and control of weeds are two methods of conserving moisture and fertility. The accomplishment of these ends offers a legitimate non-destructive field for the use of power machinery



soil moisture supply. All of these practices, which have been brought to their present state of development by agricultural engineers, are important in unlocking the elements of fertility already in the soil, and making them available for plant growth.

The development of more adequate power and tillage implements has made possible more effective use of fertility elements. Better seedbeds create a better condition for plant growth, giving the crop plants every chance to yield the greatest return of which the soil is capable. Control of weeds which rob the plants of food and the soil of its plant food elements, is of vital importance in conserving fertility and providing optimum conditions for plant growth. Tillage—summer fallowing for example—conserves moisture which aids the plant food to produce bigger crops the following season. New tillage tools and planting machinery, such as the deep-furrow drill, have made possible and profitable the cultivation of lands not fitted for crop growing with old methods and equipment.

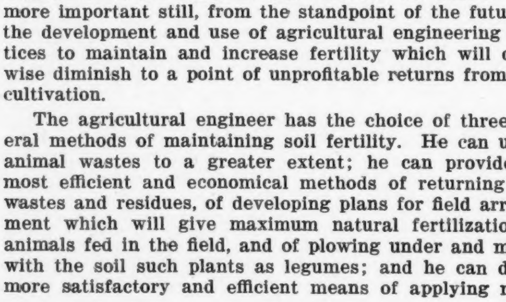
The agricultural engineer's contribution to better utilization of soil fertility has been great, and there is no reason to believe that it has reached its zenith. But more important still, from the standpoint of the future, is the development and use of agricultural engineering practices to maintain and increase fertility which will otherwise diminish to a point of unprofitable returns from land cultivation.

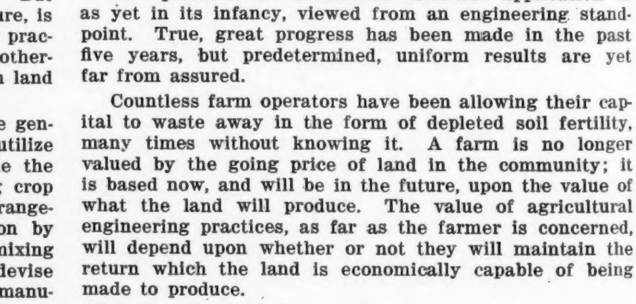
The agricultural engineer has the choice of three general methods of maintaining soil fertility. He can utilize animal wastes to a greater extent; he can provide the most efficient and economical methods of returning crop wastes and residues, of developing plans for field arrangement which will give maximum natural fertilization by animals fed in the field, and of plowing under and mixing with the soil such plants as legumes; and he can devise more satisfactory and efficient means of applying manufactured plant food in the form of commercial fertilizers. In practice, of course, he will usually want to combine all three.

A great wealth of plant food is annually wasted in the form of barnyard manure which is allowed to leach away before the residue is applied to the land. This uneconomic waste has been allowed to go on unchecked as far as the majority of farm operators is concerned. Except in the older portions of the United States, we have yet to learn that soil fertility is not inexhaustible, and little effort has been made to point out the enormity of this waste in its dollars and cents value. The labor-saving economy, and soil fertility value of livestock rotation, made possible by proper field arrangement in conjunction with a profitable system of crop rotation, has as yet to be fully realized by the majority of farmers. What could be more important from a standpoint of lower production costs than to make livestock do the maximum amount of harvesting of its own food, and from a soil fertility standpoint to return the animal wastes directly to the soil from which the plant food was removed?

The problem of commercial fertilizer application is as yet in its infancy, viewed from an engineering standpoint. True, great progress has been made in the past five years, but predetermined, uniform results are yet far from assured.

Countless farm operators have been allowing their capital to waste away in the form of depleted soil fertility, many times without knowing it. A farm is no longer valued by the going price of land in the community; it is based now, and will be in the future, upon the value of what the land will produce. The value of agricultural engineering practices, as far as the farmer is concerned, will depend upon whether or not they will maintain the return which the land is economically capable of being made to produce.





These pictures show a new idea in general-purpose tractor development, in which the corn planter is designed as a special attachment for the tractor, and is not a separate unit. The tractor was designed and developed by Dent Parrett

Engineering Possibilities of the "Combine" Idea

By E. G. McKibben[1]

THE initiation, development and perfection of machines for combining certain agricultural processes offers one of the most promising fields of endeavor for those agricultural engineers who are interested in agricultural mechanical equipment. In some instances such machines may make it possible to eliminate certain processes, just as the combined harvester-thresher has eliminated the necessity of binding and shocking grain.

It is of course true that there are at least the following additional possibilities in connection with the application of engineering to agricultural mechanical equipment:

1. Improvement of present machines from the standpoint of materials, design and performance
2. Increased capacity resulting from increased speed or size, or both
3. Adaptation of present machines to adverse operating conditions (rough, stony land)
4. New types of machines to accomplish the same work as present machines
5. New machines to take over processes at present performed by hand
6. Automatic operation.

However, it is equally true that the "combine" idea can be applied concurrently with any of the above possibilities of machine improvement and that any of the above possibilities may be applied to any machine which has resulted from the engineering application of the "combine" idea.

Advantages. Fewer laborers are often required when two or more processes are performed by the same machine. Even where there is no decrease in the number of men required, there is usually an increase in the output per man-hour.

As with labor there is often a saving in either the power required or in the output per horsepower-hour. There is also the possibility of combining two or more processes which have such a low power requirement that taken separately they give a very inefficient load for the available power unit but which when combined give about the rated load. For example, a corn planter and a 10 to 15 drawbar horsepower tractor is not a very efficient combination from the standpoint of use of power. However, if at the same time a part or all of the secondary seedbed preparation could be accomplished the tractor could be properly loaded.

Under many conditions less material is needed to construct a machine, for performing two or more processes at the same time, than to build a separate machine for each of the processes.

In some instances better results from the standpoint of quality of work and elimination of waste can be obtained by combining two or more processes. For example, under many conditions there is less loss of grain when using a combined harvester-thresher than when using a binder and a stationary thresher.

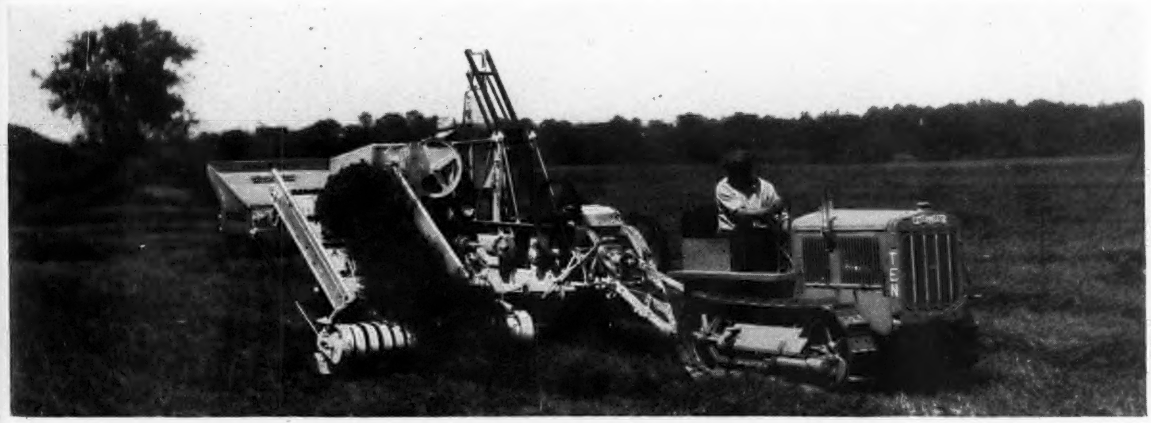
Disadvantages. Engineers will of course realize that the "combine" idea is not a cure-all. Like many other good things, it has disadvantages and limitations. In many cases it may tend (1) to reduce the flexibility of the agricultural production program, (2) to limit the district over which a given machine can be successfully used, and (3) to require better managers and operators if satisfactory performance is to be obtained.

Feasibility. As in the case of any properly managed machine development, one of the first steps, in connection with any suggested machine for combining processes, should be an engineering analysis of the probable quality of its performance; its labor, power, and investment requirements as compared with the existing machines; and the extent of the farming area in which it could be satisfactorily used. For in order to be feasible any new development must show a gain in at least one of the following items. While it is possible for a machine to succeed and still show a loss in some of these items, the sum of gains must be greater than the sum of the losses. In other words, an algebraic summation must give a positive answer:

1. Quality of work performed
2. Ease and convenience of labor required
3. Output per man-hour
4. Output per horsepower-hour
5. Cost of use (depreciation, interest, repair, etc.)
6. Extent of adaptability.

Examples. While the combined harvester-thresher for small grain is one of the outstanding examples of the "Com-

[1]Associate professor of agricultural engineering, Iowa State College. Mem. A.S.A.E.



This outfit, which gathers the hay from the windrow, elevates and bales it, is a good example of the application of the "combine" idea to farming operations

bine" idea it is by no means the only one. For instance, the common grain binder is a combined harvester-binder. The following is a brief list (not necessarily complete) of "combine" machines which are being manufactured and used at the present time:

Machine	Operation Combined
1. Plows with harrows or rollers attached	Primary and secondary seedbed preparation
2. Rotary plows	Primary and secondary seedbed preparation
3. Listers	Seedbed preparation and planting
4. Disk harrows with fertilizer attachments	Seedbed preparation and fertilizer distribution
5. Planters and drills with fertilizer attachments	Fertilizer distribution and seeding
6. Combined harvester-thresher (combine)	Harvesting and threshing
7. Field ensilage harvesters	Harvesting corn and cutting into silage
8. Portable balers with pick-ups	Gathering and baling hay

Possible Developments. The following is a brief list, not complete, of possible developments of the "combine" idea; most of these have already been tried, at least to a limited extent:

1. Primary and secondary seedbed preparation, seeding, and fertilizer distribution for crops other than corn
2. Secondary seedbed preparation, planting and fertilizer distribution for corn and other row crops where listing is not practicable
3. Cultivation and dusting or spraying for certain row crops requiring these treatments
4. Combined harvesting and threshing and summer fallow
5. Combined harvesting and threshing, secondary seedbed preparation, and seeding
6. Addition of baler to combined harvester-thresher
7. Combined harvester-sheller-stalk baler for corn
8. Potato, beet and other root crop complete harvesting machines.

CONCLUSION

In view of its demonstrated possibilities, of the fact that it does not conflict with the other possibilities of agricultural equipment progress, and of the everpresent threat that a competitor's application of it may nullify progress along other lines, every agricultural equipment engineer should be always on the lookout for opportunities to make practical use of the "combine" idea. Also, in view of the long and difficult periods of development through which some of our most successful "combine" machines have had to pass, the agricultural engineer whose vision and initiative has led him to pioneer in some new application of the combine idea should not be too easily discouraged.

Development of the Grain Combine

By Frank N. G. Kranick[1]

THERE is no doubt that the "combine" has earned its place as a machine of value on our farms. The fact alone that wheat can be harvested for from 16 to 20 cents per bushel less, than in the conventional way of handling it with a binder and thresher, justifies its acceptance by those who grow wheat for profit. Similar savings justify its use in harvesting other small grains.

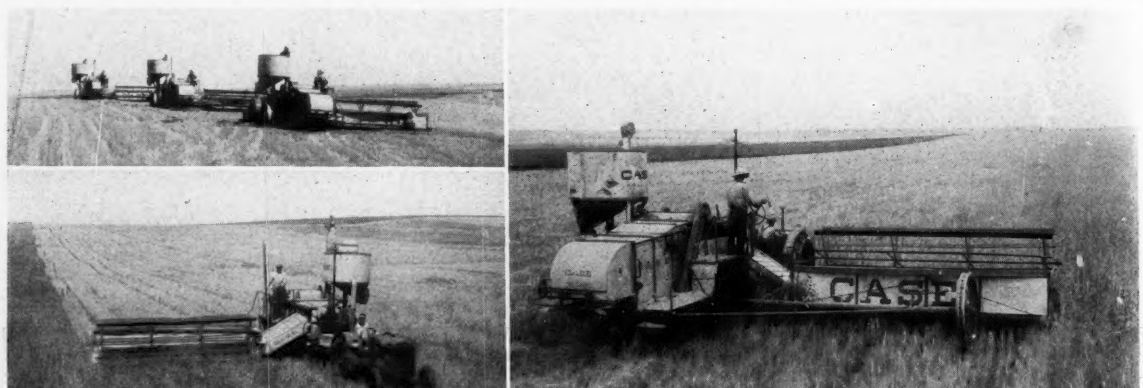
Although this machine was invented many years ago its general acceptance, like that of many other machines, is recent. In 1920 there were only about 6,000 combines in use on the farms of this country; in 1930 there were approximately 65,000 machines. In 1926 there were approximately 4,700 machines exported; in 1928 about 7300; about 8,000 in 1929; and in 1930, a considerably larger number.

[1]J. I. Case Company. Mem. A.S.A.E.

These figures clearly illustrate the acceptance of this machine in both domestic and foreign fields. Furthermore, it is given a place as a standard piece of agricultural equipment, one which has established itself firmly as a material aid in reducing the cost of producing cereals.

Mechanics. Combines are about 90 per cent thresher and 10 per cent header. There are two types in common use. One is the level land machine, used on the prairies of the West, in Canada, the Argentine and other level land countries. The other, the hillside machine, is equipped with a body-levelling device and is used in Washington, Oregon, Idaho and other areas where cultivated hills prevail. The ratio of sales is about 96 to 4 in favor of the level land type, due to the relatively small amount of territory requiring special hillside machines.

The elements of design entering into these machines vary with the ideas of the different agricultural engineers



Combining with machines having elevated bulk grain tanks to hold the threshed grain temporarily, for intermittent delivery

Tractor, combine and truck form a unit for transferring grain from the standing stalk to the bin or elevator

responsible for their development. Each, therefore, reflects in a measure the designer's ideas and the results of his work.

Unfortunately, however, we do have agricultural engineers who still choose to take the results of other men's efforts rather than develop any of their own. This is a tribute to those who have done the originating rather than a credit to those who do the duplicating.

While combines were originally used on the Pacific Coast and in the Northwest their use has gradually spread eastward to the Central West and the East. There is no doubt but what they will become a more prominent part of our agricultural equipment wherever small grains are grown.

There are some limitations, however, that prevent their more rapid acceptance on the smaller areas. These farms, which in the aggregate produce a considerable quantity of small grains, must be recognized.

Future Development. The problem before the agricultural engineer is to provide a commercially satisfying combine that will suit these areas.

Ohio, for example, ranks tenth among wheat-producing states in the Union. Unless the agricultural engineer provides a machine that will meet the needs of Ohio farmers, they will be handicapped. Of course, we may say that these farmers should let the West produce grains, but will they? Isn't it better to help them by supplying a machine unit to suit their needs?

It is quite likely that smaller combines will be produced and will find a market among the farmers of Ohio, Indiana, Illinois, Iowa, and other states where small grain is grown.

Of course, there will still be the element of weather to contend with, but grain drying equipment can be provided at the elevators when seasons demand it. Satisfactory provisions for drying the grain on the machine itself, or on the farm where it is produced, may also be developed. The windrow and pickup method of harvesting is another solution for the moisture problem.

Small combines will be provided with folding headers to simplify moving them from one field to another, across roads, through gates and over culverts. This problem is one of the major handicaps at present. To aid the user in this work calls for a quick and narrow combine folding device to save time and reduce costs.

It is also certain that these machines will be made to operate with a minimum amount of power so that they can be successfully handled by power take-offs. This will bring about designs of less weight because of the absence of heavy engines. This means less cost to produce, and reduced weight means less expense to move these machines through the field. All this will mean designs with the best materials and construction without increasing the cost to a point where it will defeat the sales. The selling price must be one that the farmer can carry and enable him to produce his crops at minimum cost.

In this picture of the future combine it is well to remember that while the large combine has established itself firmly on the larger farms as a means to reduce costs, it is also possible with the smaller combine on the smaller farms to do the same thing. In other words, the size of the farm does not necessarily govern the cost of production. It is a fact that the small farm can produce livestock or crops just as cheaply as the larger one. Supervisors, foremen and managers are not required, and an individual owner can do these same things, in most cases, much better because he is dealing with his own affairs.

It is quite likely that we may find that even on the larger farms two or three of the small combines with smaller tractors will be a means to reduced production costs. The present big, cumbersome, unwieldy and expensive tractor units will be replaced by these smaller combinations in the grain fields and outperform them to the farmer's satisfaction.

On the whole, engineering—whether it relates to the combine or any other element—is nothing more or less than the application of mechanical principles combined with sound economics and common sense. It is well to remember that no matter how well a unit is engineered and designed, or how well it is made as far as details and trimmings are concerned, unless it is a means to aid the purchaser in producing the crop he grows commercially for less by performing in a satisfactory manner in the field, it is doomed to failure.

Agricultural engineers must also realize that there is a demand existing for products that have been improved. We have been taught and educated by advertising to an ever changing economic condition, and the sooner the agricultural engineer realizes this, the quicker he will consistently bring about changes that make for improvements.

It is a fact that to change machine designs in the industry, as far as the manufacturer is concerned, involves an expense; but it is equally true that not to change may also be an expense. Therefore, we may pay for these changes in industry whether we make them or not. Our economic situation is in flux; our ideas are everlastingly changing. We as individuals—and the farmers are in the same group—demand the best.

Standardization of Farm Machinery

By W. H. Worthington[1]

STANDARDIZATION in the farm machinery industry has until this time been undertaken with great caution, due to the rapid development taking place in the transition from animal to mechanical power, and it has been felt that no standards should be undertaken or promoted which would in any way retard the originality of the designer, cause confusion, or adversely affect the industry as a whole. From this it must not be concluded that the industry has not taken full advantage of the standards work which has already been developed by societies dealing with materials and automotive design. This includes the exhaustive and most complete standards which are available through channels such as the Society of Automotive Engineers, American Society of Steel Treaters, American Society for Testing Materials, and various "simplification" programs, such as that worked out by the American Screw Thread Commission. The benefits accruing to the Society from the work of these various bodies has been extensive and comprehensive in its scope, and the agricultural machinery industry has used this work to its utmost.

It is, therefore, apparent that the wisest course for the standards work of the American Society of Agricultural Engineers to follow has been along lines of operation rather than construction. The members of the Standards Committee have accordingly worked together very closely, and have so far developed two sets of standards, one of which is of vast importance and which will play an important part in the future power-farming development. This pertains to the tractor power take-off attaching shaft, its speed and its location on the tractor with respect to the drawbar, inasmuch as it is the means of connecting the power-driven unit with the prime mover, and affords great benefit to the ultimate users without imposing undue restrictions on the designer. The other standard upon which considerable work has been done pertains to disks for plows, harrows, etc., and which is of rather doubtful value, inasmuch as the status of the industry has changed so greatly since this work was undertaken that in some of its most important details this standard does not reflect a true picture of the present implement manufacturing situation or requirements.

We are coming into an era of power farming when future work on standards can probably be undertaken with the prospect of far more benefits to the industry than at any time heretofore, as so many more uses of power farming equipment have either already been set up or are in the process of development than at any time previously, and other uses are passing out of the agricultural picture to an extent which justifies a change in many of the past views. For example, it has heretofore been very difficult to confine tractor belt speeds to within a comparatively narrow range owing to the many different types of belt operated machines, and the fact that it was almost out of the question to adopt a belt speed which would be at once satisfactory for a general-purpose tractor and the extremely large agricultural tractors which practically dominated the tractor field a few years ago. The matter of tractor belt speeds is one which at this time might be very properly reconsidered.

The development of electrical power for agricultural purposes introduces the problem of providing a satisfactory standard of belt speeds adaptable for lighter power-driven machines requiring for their operation all the way from a fractional horsepower motor to motors of possibly 8 or 10 horsepower. The development of such standards can provide for a more satisfactory and balanced motor-drive application, and insure operation at a relatively higher power factor. This in turn effects the maximum of economy so far as initial installation cost of rural power electric equipment, as well as the cost of transformers and power lines necessary to handle such peak loads as may be required. In connection with belt speeds the matter of belt widths may possibly come in for consideration with the idea of reducing to a minimum the number of widths and diameters of pulleys which any manufacturer may be called upon to supply.

One of the most important things at this time is a standardization of nomenclature and terminology in all of the various branches of agricultural engineering. Such standardization should properly be a cooperative effort on the part of the various technical divisions of the Society and will be of great benefit in the future in assigning the proper names to different farm operations, tools, and machine parts.

Another highly important matter which at this time may properly be considered in the light of requiring work by the Society is the determining of specifications for tractor fuels. The present condition of the petroleum industry is far from stable and admittedly prices on petroleum products are artificial, having little relationship to production costs. Much fuel is being offered for sale in many parts of the country which on account of its poor quality and high sulphur content will damage tractors to an extent which will far more than offset any possible saving which might accrue. On the other hand, many lower-priced tractor fuels of a suitable quality are being offered, and in such localities as these are obtainable, power farmers are effecting marked economies through their use. Work is being undertaken by the Committee on Fuels and Lubricants of the Society which offers wonderful possibilities for demonstrating the value of our Society as a fair and impartial agency for harmonizing the best interests of the several industries affected and affording to the tractor users the opportunity of taking full advantage of low fuel costs in power-farming development.

In conclusion, it may be stated that so long as the Society exercises due caution in undertaking projects of standardization and limits their activities to such matters as represent a standardization of requirements and operation rather than matters of detail construction, the benefits to be obtained will be enormous.

In this period of rapid development of farm equipment, standards of performance, safety, nomenclature, fuel specifications, etc., would be particularly valuable

[1]Research engineer, John Deere Tractor Company. Mem. A.S.A.E.

Intra-Company Standardization of Farm Equipment

By O. B. Zimmerman[1]

THIS being the twenty-fifth year of this engineering society's activities, it should be permissible to review our industry's work along the lines of standardization. It should again be made a matter of record that the farm implement industry, to its great credit, was among the very first to develop and establish the basic principles of standardization.

It was in the implement industry that special production machines, and the jigs and fixtures so essential to mass production, were first employed to an appreciable extent. The industry was the leader in this field. Furthermore, the farm implement industry was the first to cut deeply into the costs of production, and the first to share the benefits of such reduction with the ultimate consumer, notwithstanding the fact that some other industries have capitalized on these ideas as being new in industry.

As a background, then, let us sketch in a little of the picture as we saw it forty years ago. As it applies to other than the implement industry, standardization was not at that time a prominent factor in the production program. What we know today as a factory was then, more often, regardless of size, a "shop." In many industries the "shop" that produced a refined product in multiple was more than glad to get an order for ten, or even five, machine tools or engines of a kind, while the larger units went through in ones and twos.

Progressive assembly in its earlier form was known in the implement industry before it had been employed in other industry. Much of the credit is therefore due it for these progressive industrial ideas, credit which has, to a large extent, been denied them. Taken in general, other industries were producing so few multiple products that their programs did not demand the inclusion of such procedure. "Quantity production" is a comparatively modern term. "Tolerance" in those days was thought of mostly in connection with religion. The manufacturing pattern was the blueprint or more often a "sample," and the precision tools were the vernier, "mike," calipers, and the steel scale. Adherence to base dimensions depended upon the "feel" of the individual craftsmen. There was much filing, and scraping, prying, kinking, or "running in" of parts to make them fit. A few thousandths, or even a hundredth, from the base dimension was unimportant, if a part fitted with the part with which it had to work in a given machine. That was much more important than that a part should interchange with the corresponding part in another machine.

Naturally such procedure was productive of identical parts that were materially different as to finished dimensions. Worn lead screws, or gears on the lathes on which cylindrical, tapered, or screw parts were produced, resulted in products which were delightfully unlike. The inspector could readily distinguish between the output of two men, and knowingly attributed characteristic variations to the "feel" of the lathe men. His job was to see that a finished machine "got by" in good running order. Interchangeability, part for part, as now, was not demanded then.

Be it recorded, however, that the expert mechanic of forty years ago was a good mechanic, very often a past master of his craft. His product was the ideal product of the day, and because his employers and their customers were content, he was content. Indeed, taken individually, the machine products of the day were remarkably good, considering the equipment available, and the comparative lack of knowledge of materials and processes.

I wonder if any shop still has a lathe whose legs are decorated with bunches of grapes, leaves or peaches, expertly carved in the patterns to provide not only beauty but utility in the form of stability and rigidity in the lathe support.

Nevertheless those machine tools turned out a good product. While present-day stability and size were lacking, they were not necessary, because present-day speeds and stress were not the mode.

Such were the tools many an apprentice worked upon in the early nineties.

There is a definite lesson in this reference to the methods and equipment of forty years ago. No manufacturer of today could produce quality products in quantity under such methods, or with such equipment. The variations from standards then permitted could not be tolerated now. Regardless of exterior ornamentation,

Intra-company standardization makes possible interchangeability of parts, progressive assembly and resultant high production, high quality, low first cost, and low maintenance cost of modern farm machinery

[1]Supervisor of materials and standards, International Harvester Company. Mem. A.S.A.E.

the deviation from standard fits which characterized machine products then would make those products discreditable now. Today, internal fits must be not only good but standard within certain prescribed tolerances which permit of absolute interchangeability of identical parts.

Necessity was ever the mother of invention. With the increase in the sale of machines came the necessity of making those parts subject to wear and breakage interchangeable, so that parts could be more readily secured. And with further increase came the problem of dealers' inventories of repair parts. Finally came the progressive assembly, where parts originating in other departments of the factory, or indeed in other factories, must enter into the complete assembly in the brief time alloted to the inclusion of those particular parts. And so came the need for standardization.

As an example of progressive assembly, I cite one with which I am familiar. Today, with a program which permits a complete tractor assembly to be made in two and one-half hours, starting with a unit frame, then successively the addition of the various parts, painting, drying, fueling, lubricating and operating under its own power, all in the time specified, it is inconceivable that time could be allowed for individual fitting of parts. A single bolt, a part, or a subassembly off standard would mean holding up the whole line—an inexcusable delay. All must move along smoothly, on time, and in one direction only, and that direction forward.

That is the result of standardization.

Let me ask, Whom are we to draw into the picture of standardization? Whose interests are we to consider? The answer now is: The producer, the distributor, and the consumer, which, by the way, represents a viewpoint considerably enlarged over that of the 'nineties.

The producer is affected because of the need of low production costs, and because of his determination to attain regularly his ideal of quality, to the end that those who purchase his product will be satisfied customers—repeaters. The distributor is interested because he knows that standardization means lower inventories, and increased ability to serve his trade. The consumer's interest is in the prompt replacement of a worn or broken part with one that is of satisfactory quality and fit, at a reasonable price.

I believe that the incorporation of this threefold service idea has, in the last few years, greatly enlarged the viewpoint of good standardization.

Today a comprehensive standardization program running continuously through any company's activities is bound to result in substantial economies in manufacturing, production, distribution and accounting. Such a program is worth while even in the case of a small concern, but it is still more so in the case of an organization of smaller companies into a single operating unit.

The present trend of industry is toward consolidation and the elimination of duplication of effort. Within the last generation public utilities, and the manufacture of automobiles, steel and other important products, including the manufacture of farm implements, have joined this movement toward centralization.

Aside from the financial and managerial problems involved, which of themselves produce huge responsibilities, there arises with each such movement a maze of serious problems in intra-company standardization. Economic necessity forces the issue of reductions in varieties of similar products, and mass production of similar parts, in order to attain minimum production costs.

Too often the initial effort at standardization is sporadic, and without a planned, adequate and definite preview of the products and the processes involved. Disconnected from any set program, items which seem to offer opportunities for spectacular showings are seized upon and put through the standardization mill with a rush which seems to promise well. But because the start was made without a definite goal, the standardization program too frequently collapses before the possibilities of such a program have been canvassed. This is relatively poor business. An intra-company standardization program should be worked out in a broad way, to cover parts, design, materials, supplies, procedure, specifications, with the goal unity of design, of materials in quality and kind, of graduated series of sizes, of fits and tolerances. The study should cover sources of supply, raw materials, and semi-finished and finished goods. Finally, there should be meticulously prepared specifications covering every item of manufacture.

The farm truck is distinctly a product of intra-company standardization

In any standardization program there are problems arising from differences in manufacturing equipment, differences in shop procedure, in shop processes, methods of inspection, etc. When, as in the case of merged companies. two or more organizations which have been functioning separately are brought under one management, the merged personnel, with its varied experiences, ideals and rotions, adds to the complexity of standardization problems, retarding or expediting the application of standardization to the finished product.

Taken en masse, machine products, whether they be machine tools, watches, agricultural or mining machinery, electric or automotive units, printing presses or railway equipment, when completed and ready to function, are found to be made up of a number of similarly functioning elemental parts, as, for example, frames, shafts, levers, springs, bearings, clutches, brakes, lubricating devices, fastening devices, etc., etc., the functions of which are disclosed by their names.

These elements with their variety meet certain typical requirements, according to the machinery group to which they belong. For each element there is a certain size range and certain desirable characteristics peculiar to the machinery group to which it belongs. It is logical, therefore, that to attain the optimum in standardization, these series of elements should be studied within their typical functional groups. This is a point to which not enough attention has been given. The functional grouping should be prepared for any industry, and should be made the basis for a mass study in standardization.

A Decade of Farm Electrification

By E. A. White[1]

TWO groups of engineers, generally working independently of each other, have played prominent roles in the development of electric service for the farm. The electrical engineer has builded an electrical service foundation, large generating plants, high tension transmission lines, substations and distribution lines from and through which there flows twenty-four hours a day the electric current. The agricultural engineer through research studies, investigations and surveys, has developed the art and science of putting this electrical energy at work on the farm. Thus the work of the engineer has again effectively linked two of our great industries, with every promise that agriculture will increasingly look to electricity as a source of energy, while the electrical industry will expect agriculture to absorb an increasing percentage of its output—both energy and equipment.

Without the large generating stations, high-tension transmission lines, substations, distribution lines, motors and generators which the electrical engineer has designed and built, any marked extension of electrical service into agriculture, such as has taken place during the past decade, would have been impossible. A little thought leads directly to the conclusion that such an electrical foundation was necessary before there could be such a thing as large-scale electrical service on the farms. Some of the outstanding achievements in this direction are summarized in Table I, these data being taken from reports issued by the National Electric Light Association.

With the foundation to make energy available, furnished by the electrical engineer, the agricultural engineer eagerly grasped the opportunity for devising ways and means to put this electrical energy at work in agriculture.

The start for the introduction of electrical service to the farm on a national scale was an investigation program, designed to determine what electricity would and would not do in this field. The plan and extent of this program are sufficiently well known to make a discussion of it unnecessary here. However, the results have furnished conclusive proof with reference to the efficiency of this method for the development of the use of a new form of energy in agriculture. The neutral investigator has furnished remarkable results at a low cost. Mistakes have been held to a minimum. Furthermore, the results

[1]Director, Committee on the Relation of Electricity to Agriculture. Charter A.S.A.E.

Table I.

Generating capacity, steam or internal combustion, 1922	14,474,217 hp
Generating capacity, water power, 1922	5,822,018 hp
Total, 1922	20,296,235 hp
Generating capacity, steam or internal combustion, 1929	29,900,000 hp
Generating capacity, water power, 1929	10,900,000 hp
Total, 1929	40,800,000 hp
Generated by fuels, 1920	27,405,000,000 kwh
Generated by water power, 1920	16,150,000,000 kwh
Total, 1920	43,555,000,000 kwh
Generated by fuels, 1929	62,723,391,000 kwh
Generated by water power, 1929	34,628,994,000 kwh
Total, 1929	97,352,385,000 kwh
Generated by water power, 1920	37.1 per cent
Generated by water power, 1929	35.6 per cent
Consumption of coal per kwh, 1919	3.20 pounds
Consumption of coal per kwh, 1929	1.69 pounds
(The 1929 coal consumption was 53 per cent of the 1919 consumption.)	
Length of transmission lines, 11,000 volts and over, 1926	130,283 miles
Length of transmission lines, 11,000 volts and over, 1929	159,442 miles
Maximum voltage, 220,000	
Size of Community	**With Electric Service**
1000 population and over	100 per cent
Between 250 and 1000 population	50 per cent
Less than 250 population	25 per cent

Tulare Lake Ranch from the air. A large-scale electrified farm in the San Joaquin Valley of California

of these researches, investigations, and surveys have been made available. There are at least 200 printed publications relating to the subject, and there are two magazines devoted exclusively to it, besides numerous articles, public addresses, radio talks, and demonstrations. For the objects sought the right kind of publicity is just as important as conducting the investigations.

There has been a substantial although not a phenomenal growth in the number of farms using electricity. The data given in Table II are furnished by the National Electric Light Association.

Table II

Date	Number of Farms with "High-line" Service
December 31, 1923	166,160
December 31, 1928	460.969
December 31, 1929	556,871
December 31, 1930	647,677

Thus at the beginning of the present year between 10 and 11 per cent of the 6,297,877 farms of the United States had "high-line" electric service. In addition to this there are perhaps between 300,000 and 400,000 farms with individual electric plants, although reliable figures with reference to this are not yet available. From this it appears that approximately 1,000,000 farms use electricity to a greater or lesser degree.

There are remarkably few developments in agriculture which can be traced solely to the influence of electricity. As a rule, electricity enters into competition with other forms of energy for its share of the farm power load. The same is true of the electric motor; it competes with other prime movers. Perhaps the chief exception to this statement is the use of ultra-violet and other rays. Even in this case electricity is competing to a large degree with similar rays emitted by the sun. The desirable perspective perhaps would be to look upon electric service as one of the distinct possibilities for agriculture, with its ultimate place being determined by its peculiar and distinct characteristics in competition with other forms of energy which also have properties peculiar unto themselves.

Perhaps electricity has had its most marked effect upon the development of agricultural equipment in the stimulus it has given to increased efficiencies. It is relatively easy to measure energy input when electricity is used. This afforded the engineer an opportunity to study power requirements which, coupled with the desirability of low demand, have been an important factor in equipment development during the past ten years. Splendid examples of this are to be found in the developments relating to chick brooding, feed grinding, and ensilage cutting.

The use of electricity has made available a refrigeration service heretofore unknown on the farm. The place to refrigerate a perishable product is at, or at least as close as economically possible to, the point of production. This process offers opportunities for the farmer to market a higher quality product in milk, butter, eggs, vegetables, and fruit.

The technical development of equipment for use in the home is so well known as to require no discussion here. The significant fact is that these developments make it possible for the farm home to be as modern as any city dwelling. The handicap of no modern conveniences in the home is being rapidly lifted from the farm community.

The farm electrification situation as indicated by developments during the past decade may be summed up as follows: Electricity has made an effective entry into the agricultural field. It is now used for practically all stationary operations to a greater or lesser extent. Chief emphasis to date has been directed largely to adapting its use to established practices. The prospects are most encouraging. The next decade should bring forth developments made possible by the properties of this form of energy. We are just on the verge of finding out what influences the use of electricity will have on agriculture.

The Uses of Artificial Light in Agriculture

By Harry L. Garver[1]

IT IS only recently that any great amount of attention has been paid to the use of artificial light for the stimulation or control of plant and animal growth. Interest in this has not been focussed on the visible part of the spectrum alone, but on the entire range of energy radiations.

We might well consider the peculiar penetrating ability of radiant energy at different wavelengths. Starting at the very short X-rays, where the penetration is high, we find that this particular property diminishes until we reach the middle of the visible spectrum, where visibility in man is highest. After passing this low penetration spot, about the yellow band, penetration again increases until we get well into the short infra-red; then apparently it reduces until we find again a superficial effect when the long infra-red or heat waves are reached. Then again in the radio waves we have deep penetration.

Since at the present time we are so much interested in the ultra-violet part of the spectrum, some reference should be made to its properties. It is readily absorbed. Few substances form good transmitting media. Perhaps fused quartz is as good as we have. Ordinary window glass does not transmit waves shorter than 3200 Angstrom units (Au). "Corex D" glass transmits a fairly high percentage of these wavelengths down as far as 2600 Au, while "Corex A" will transmit wavelengths as short as 2130 Au. Ultraviolet rays shorter than 2900 Au do not penetrate the earth's atmosphere to any great distance. That this is true may be seen from the fact that the sun's rays reaching the earth do not contain waves shorter than 2920 Au. Light fabrics such as white cotton transmit some ultraviolet energy. The amount transmitted depends mostly upon the looseness or openness of the weave.

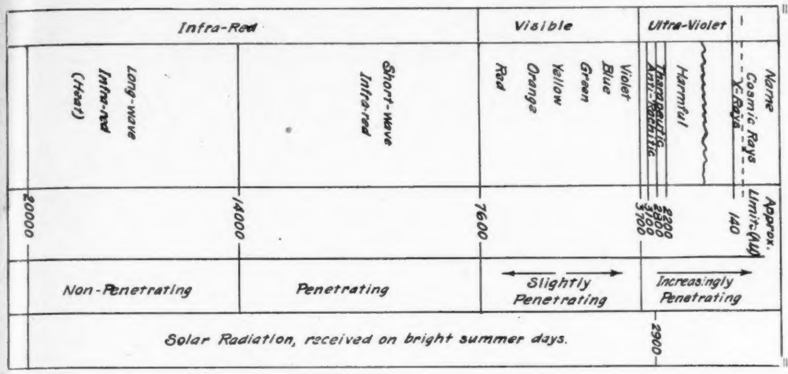
There are now on the market several substitutes for glass that will transmit (when new) fairly high percentages of ultra-violet energy. The permanency of their transmitting properties is somewhat questionable, as exposure to climatic conditions and ultra-violet rays themselves cause them to lose their transmitting qualities rather rapidly.

Ultra-violet rays are also active in producing chemical changes. This may be seen by their effect on photographic plates and by their action upon certain foods. Between 2800 and 2200 Au, ultra-violet rays possess beneficial qualities of a therapeutic character, but they should be used only under the direction of those especially trained. Not only are they of little or no value in the curing and preventing of rickets, or in the stimulation of phosphorus and calcium metabolism, but it is thought that this part of the spectrum is destructive to vitamin A, and also to vitamin B_2 (or G). Food consumed for its vitamin A properties should not be exposed to this band of the ultra-violet spectrum.

It is only those wavelengths between 2800 and 3100 Au which are of value in the treating or preventing of rickets. It is exposure to this band which causes sunburn or tanning. While tanning is an indication of exposure to radiations in the anti-rachitic band, it is not essential to successful treatment. Waves shorter than 2000 Au also are thought to be harmful, and probably offset the good qualities obtained from that part of the spectrum between 2800 and 3100 Au.

There are three principal and practical artificial sources of ultra-violet radiations which may be used outside of the laboratory. These are the carbon arc, mercury vapor

[1]Rural electrification investigator, State College of Washington. Mem. A.S.A.E.



A portion of the spectral energy chart showing solar radiation received on bright summer days, and indicating the physical characteristics of the several wave length groups

arc, and the tungsten filament operating at a very high temperature. There is now on the market a lamp having a combination tungsten filament and mercury arc which emits rays well down into the ultra-violet spectrum. By enclosing this light source in a "Corex D" glass bulb, there is a fairly definite cut-off at about 2800 Au, which makes it a satisfactory source of ultra-violet rays for use by the layman. This lamp also emits rays through the visible and into the infra-red spectrum, making it not only a source of ultra-violet, but also a source of visible light, which gives it a dual purpose.

We should also mention here that ultra-violet rays are not reflected by many substances. Ordinary aluminum or aluminum oxide and chromium-plated surfaces are probably the best reflectors. Common porcelain-coated reflectors, while very efficient in the reflecting of ordinary light, are practically useless for reflecting ultra-violet rays.

There seems to be reason for believing that ultra-violet irradiation may be overdone. Just where the limit of usefulness falls probably depends upon the individual. Here the advice of the physician or veterinarian, as the case requires, should be sought.

The applications of infra-red radiations in agriculture have been more or less lost sight of in the rush of new discoveries in the applications of ultra-violet. The deep penetration of short infra-red and very short radio waves are accompanied by internal heating, apparently due to their absorption by the tissue through which they pass. Glow type air heaters have been used in hog houses at farrowing time for keeping the pigs and sows warm. Perhaps the practice has merits to which little thought has been given. It may be that we shall also find, for certain periods at least, that the glowing type of heating unit is better than the non-glowing type for brooding chicks.

It has been found by animal and plant breeders that X-ray treatments of breeding stock will produce mutations, or sports. Whether or not the change is a result of killing a chromosome or creating a new one, it opens a new field of investigation to the producer of improved species of domestic plants and animals.

Electric lights have been used in orchards and vegetable gardens to lure night-flying insect pests into traps, with some success. The scheme cannot be said to be universal, since some of the worst orchard pests are not attracted by such lights. The codling moth belongs in this class. It may be that a light of special color or some other special characteristic may be used as a lure to trap these pests also.

Perhaps the most outstanding application of artificial illumination in agriculture, aside from that of lighting the home, is that of lighting laying houses. Not only is it of convenience to the poultryman, but it has resulted in definite increases in returns from his flock. The convenience to other branches of agriculture of artificial illumination by electricity, is difficult to estimate. Certainly its value reaches farther than the mere lighting of the barns for the convenience of the workers. The lessening of fire hazards should also be considered, and it should be reflected in the insurance rates on all farm structures.

While it has been pretty definitely proven that plants do not require ultra-violet energy for vigorous growth, some floriculturists are using ordinary electric lamp light to stimulate the growth of plants and thus get more or better crops. This, of course, is not often practical in the field, but for vegetables grown under artificial conditions, such as greenhouses, it may be profitable to furnish light from artificial sources. It may not be too soon to venture a prediction that the time will soon arrive when the greenhouse without artificial light for the control of plant growth will be in the position of the poultry laying house of today without artificial light for its influence upon egg production.

A farm scene in western Washington. The electrification of farms may some day be supported by the night lighting of main routes through rural areas, or vice versa

Research in Rural Electrification

By George W. Kable[1]

INVESTIGATIONS of the use of electricity on farms were first undertaken in an organized way in 1923, with the establishment of the Red Wing project in Minnesota. This project, with headquarters at the University of Minnesota, was a cooperative effort of the agricultural interests and the electric power companies of the state to learn more of the possibilities for electricity in agriculture. During the same year the national Committee on the Relation of Electricity to Agriculture was organized. It has since functioned as the stimulating and coordinating agency for farm electrification studies throughout the country.

Between 1923 and 1927 twenty-three states established cooperative agencies for the investigation of rural electrification. In most cases these states undertook orientation studies to determine the status of electric development in the rural areas. The conclusions resulting from these surveys were significantly similar. They pronounced the use of electricity on farms as practiced at that time to be unprofitable, both to the farmer user and to the distribution company. The existing sliding scale of rates, which was quite general, and the few outstanding examples of profitable uses of electricity on farms suggested the solution. In order to have lower rates for the farmer and larger returns for the power company, there must be a much more extensive use of electricity on farms.

The efforts of the state committees were immediately directed to the economics of the use of electricity on farms. Most of the committees conducted their work in cooperation with the state agricultural colleges. Hundreds of different applications of electricity to the farm and home were subjected to test and economic study on experimental lines and farms established for the purpose. The early research efforts were confined almost entirely to a scrutiny of the economics and mechanics of existing equipment and appliances adapted to farm use. Machines and processes which showed weaknesses were taken to the laboratory for further development and study.

Out of the farm electric laboratories have come new designs for equipment and machines for electric operation. The result has been not only the development of electrical equipment, but the improved design and increased efficiency of farm equipment in general.

The engine-driven silo filler was found to have blower speeds and designs which were wasteful of power. New ensilage cutters have been placed on the market having greatly increased efficiency, and power requirements as low as five horsepower. The electric motor has been responsible for introducing the hammer-type feed mill on the farm and the designing of a number of these mills particularly to answer farm needs.

The development of small, electrically-driven refrigeration plants and of insulated cooling tanks has resulted in improved milk handling on many farms.

Starting with the rebuilding of old oil-heated incubators to use electric heating elements, the hatchery business in the United States has progressed rapidly toward complete electrification. Electric brooders have been devised which eliminate much of the labor and uncertainty of growing chicks. The use of lights for increasing winter egg production has become a firmly established practice.

Electric heating of hotbeds, propagating benches, and even truck gardens, has been developed to the point of economic feasibility.

In addition to the specific investigations in rural electrification, there are several hundred studies under way in public and private laboratories in which the use of electricity in agriculture is involved.

Some fifty investigations of ultra-violet light are under way. These include the effect of ultra-violet on nutrition, growth, and prevention and cure of diseases of animals, effect on the hatchability and vitamin content of eggs, the sterilization of milk, the stimulation of plants and seeds, alteration of sex in flowers, and control of plant diseases.

The effect of electric charges on different substances in nature is being studied in a number of laboratories. In Pennsylvania for instance, the potency of nitrifying bacteria on legumes has been determined by the measurement of electric charges on these bacteria. A similar study on the variation and effect of different electric charges on pollen grains is under way. Soil chemists in different laboratories are finding that the behavior of different soils is dependent to a degree on the electric charges carried by the soil particles.

While much progress has been made in applying electricity to established farm practices, there is still greater prospect for development of processes which are now in the research stage.

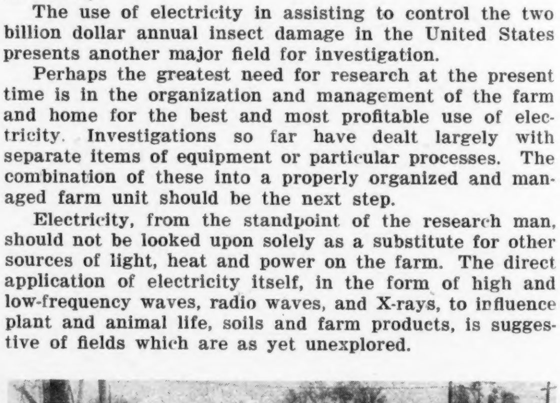
The use of electricity for field power presents an opportunity for the development of a load running into billions of kilowatt-hours annually. Several attempts to develop tractive equipment adapted to American agriculture are now under way.

The stimulation of plant growth through the direct or indirect application of electricity still offers possibilities. The immensity of the possible application and the many angles of approach, together with favorable reports from various sources, maintain this as a subject worthy of further study.

The use of electricity in assisting to control the two billion dollar annual insect damage in the United States presents another major field for investigation.

Perhaps the greatest need for research at the present time is in the organization and management of the farm and home for the best and most profitable use of electricity. Investigations so far have dealt largely with separate items of equipment or particular processes. The combination of these into a properly organized and managed farm unit should be the next step.

Electricity, from the standpoint of the research man, should not be looked upon solely as a substitute for other sources of light, heat and power on the farm. The direct application of electricity itself, in the form of high and low-frequency waves, radio waves, and X-rays, to influence plant and animal life, soils and farm products, is suggestive of fields which are as yet unexplored.



An experimental electric field tool receiving power and direction through wires from a mast in the center of the field

[1]Director of research, Committee on the Relation of Electricity to Agriculture. Mem. A.S.A.E.

Requirements of Dairy and General Farm Refrigeration Equipment

By James R. Tavernetti[1]

DURING the past ten years widespread interest has been developed in refrigeration, and at the present time the manufacturing of refrigeration equipment is one of the leading industries in the United States. The most important factor in the creation of this interest has been the development and advertising of the small mechanical refrigeration units. Other factors have been the publicity given by various agencies to better foods and health protection and the more recent developments in frozen foods and beverages. This interest has not only been aroused in the urban centers, but also in the rural field.

Refrigeration on the farm, while used to some extent at the present time, has been retarded so far for several reasons. First, approximately only 500,000 of the 6,500,000 farms in the United States have electric service at the present time, and the majority of these have obtained this service during the past five years. Thus mechanical refrigeration could not be used, and the farmer had to depend for his refrigeration upon ice, cold water and cellars, and these were not always available or satisfactory. Second, as the farms are widely separated and it required more sales effort and expense to reach them, the manufacturers and sellers of refrigeration equipment have followed the path of least resistance and concentrated their efforts upon the urban dwellers, stores and restaurants. Third, the initial cost of the equipment is relatively high due to the large size needed.

Farm refrigeration may be divided into two types: (1) The "specialized," to take care of the farmer who wishes to preserve some particular type of product until he is able to market it, or until he can get a higher price, and (2) the so-called "general utility," to take care of the farmer who wishes to preserve the food raised on his farm until it is consumed, or who wishes to get the advantage of lower prices by buying in large quantities.

Of the specialized type, the cooling of milk on the farm has been and will probably continue to be the most important. When purchasing refrigerating equipment for milk cooling, the farmer is able to look ahead and determine just what grade of milk or cream he can produce and what increase in revenue he will receive by producing that particular grade. On the other hand, in the refrigeration of other farm products such as fruits, vegetables, berries and poultry products, he is gambling upon the increased returns he will receive as there is no set standard of quality and no set price. Other factors which have hastened the refrigeration of milk on the farm have been the increasing requirements demanded by state and city dairy laws and the conventional method of handling and marketing milk, making possible the development of standard types of refrigeration plants for this use. With other types of products, each farm has been somewhat of an individual problem, depending upon the amount and kind of product to be cooled, method of handling, and length of time it must be held.

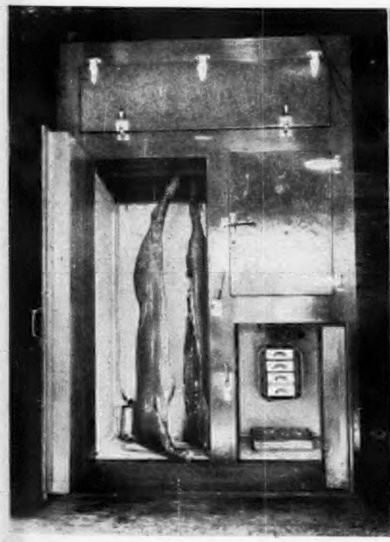
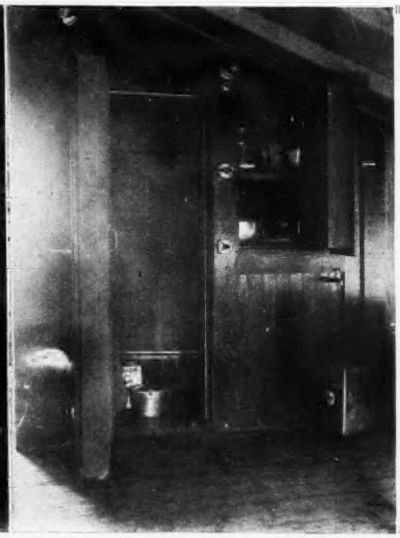
The "general-utility refrigerator," as the name implies, is one which is designed to provide storage for all types of foods. Its use is similar to the small household type, except in the quantity of food it must take care of. At the present time there are no refrigerators on the market that are designed especially for this purpose. Those that are being used have been constructed on the farm, or are the commercial types. The latter, while fairly satisfactory, have not been used more because of their high initial cost and because they have not been designed for farm use. The California Committee on the Relation of Electricity to Agriculture has been making a study for the past two years of this type of farm refrigeration, and from this study to date the following conclusions have been drawn:

1. When the refrigerator is located near the kitchen where it will be opened often, the non-walk-in type is the more suitable because of its greater convenience. When it is located where it will not be opened often, and large amounts of food are to be stored, the walk-in type is more economical because of its lower cost per unit volume.

2. A 45 to 60-cubic foot refrigerator seems to be the most practical size for the non-walk-in type; 100 to 150 cubic foot is a desirable size for the walk-in type.

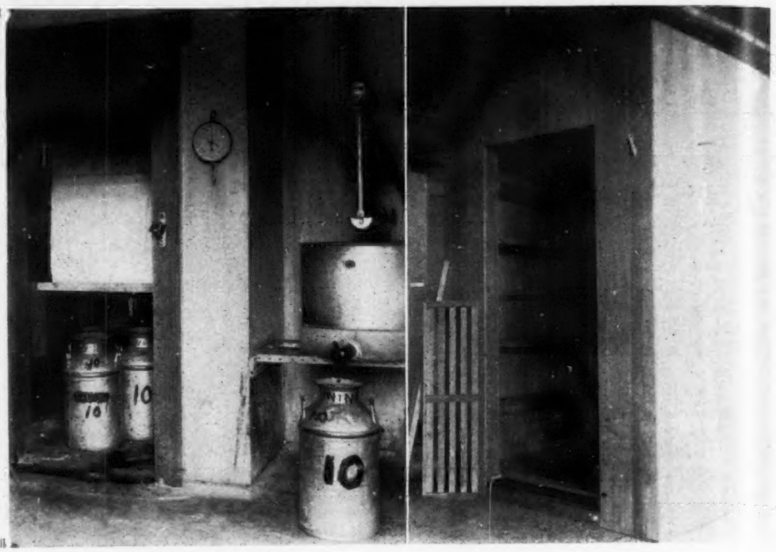
3. A general-utility refrigerator on the average farm

[1]Field engineer, California Committee on the Relation of Electricity to Agriculture. Assoc. Mem. A.S.A.E.

(Extreme left) A brine system, dry storage farm milk cooling plant typical of those used in California. The storage box was constructed on the farm by the dairyman and has a floor area of four feet by four feet. This plant will take care of 100 gallons of milk per day. The compressor is of three-quarter horse power and air cooled. This plant cost the dairyman $800. (Left) A walk-in type of farm refrigerator designed and constructed for test purposes by the California Committee on the Relation of Electricity to Agriculture. This box has interior dimensions of four feet by five feet by eight feet, with a net storage capacity of 125 cubic feet. It is insulated with three inches of sheet cork between tongue and groove lumber, and is of sectional construction. This box could be constructed and equipped on the farm for approximately $650

(Right) A non-walk-in type of general utility farm storage box designed, constructed, and tested by the California Committee on the Relation of Electricity to Agriculture. Across the top is the main cooling coil, on the left is the meat compartment, which is separated from the rest of the box by a one-inch partition, on the right center is a compartment with shelves and on the bottom right is a compartment containing an ice making coil. (Extreme right) A combination walk-in and non-walk-in type of farm refrigerator sold by refrigerator machine agency and in use on a farm. On the left is a walk-in compartment where large pieces of meat or boxes of farm products can be stored, and on the right is a small shelved compartment for small foods such as shown in the picture



should provide storage for meat such as a lamb, veal, hog, or quarter of beef, such other farm foods as a crate of eggs, a 5 or 10-gallon can of milk or cream, boxes or crates of fruit, vegetables or berries, and desserts and table dishes.

4. The length of time the foods are kept in storage is quite variable. Usually fresh meats are kept from two to five weeks; cured meats up to six months; fruits up to three months; vegetables, eggs and berries up to a month; milk or cream up to a week, and desserts or left-overs from meals only a few days.

5. The making of a small quantity of ice for table use is desirable. If this is not available, a coil or small tank in the refrigerator which will furnish cool drinking water through a spigot on the outside is satisfactory.

6. It is desirable that there be two or more separate compartments so the odor-giving and odor-absorbing foods may be kept separate. This feature is needed because most of the foods stored are unwrapped or in open containers and may be kept for a relatively long period of time.

7. Temperature should be between 35 and 40 degrees (Fahrenheit) and it is desirable that the temperature in each compartment be regulated to suit the food stored in it.

8. The refrigerator should be of sectional construction to permit passage through a 2½ by 6½-foot door.

9. There is a need for a refrigerator designed especially for this purpose and which will sell for a lower price than the comparable commercial sizes now on the market. In the design of this refrigerator, particular attention should be given to insulation, convenience and sanitation.

Farm refrigeration in general offers an attractive field for development. However, it is not a field that will open up over night, but one which will develop slowly and will require considerable sales effort. Several factors are contributing to this development. First, the number of farms having electric service is increasing yearly, and within the next ten years it is predicted that 2,000,000 farms will be electrified. This will make possible the use of mechanical refrigeration on these farms. Second, as the urban field becomes saturated, the manufacturers and selling agencies will turn to the farm field. Also with the electrification of more farms, the power companies are placing power salesmen in the field to build loads on the farm lines, and refrigeration will be pushed by these salesmen. Third, with overproduction becoming a serious problem and the public demanding choice foods, quality is becoming an important factor in the returns received from farm products. Not only will the farmer try to produce high-quality products, but he will desire some means of preserving that quality until the products are marketed. Fourth, the farmer realizes that if he had refrigeration it would be economical to raise more of the food he consumes, or to buy it in large quantities at lower prices and store it until it could be consumed without waste.

Ice-Well Refrigeration for Dairy Farms

ICE wells for cooling and storing milk and cream on the farm may be a satisfactory solution of the refrigeration problem on many dairy farms where the usual methods are too expensive or impracticable.

The ice-well "refrigerator" consists primarily of a bit in the ground in which a large solid cake of ice is formed by running a small quantity of water into the hole daily during freezing weather. The method has been tried to some extent on dairy farms in Canada, but no information regarding its adaptation in the United States had heretofore been available.

Following closely the plans suggested by the Saskatchewan Department of Agriculture, the U.S.D.A. Bureau of Dairy Industry, in cooperation with the North Dakota Agricultural College, constructed an ice well in the fall of 1928 at the U. S. Dairy Experiment Station, at Mandan, N. D., to test the possibilities of the method under conditions there.

The mean average temperature in this vicinity for January and February was -2.9 degrees and 4.6 degrees F, respectively. The highest temperature for the two months was 38, and the lowest was -43.

Storage of cream was started May 25 and the ice lasted until September 28, a period of 126 days.

Careful records were kept throughout the summer. Cream cooled with well water to 56.5 and placed in the rack in the pit at 8:30 a.m. was cooled to 48 within three hours and to 42 by 4:30 p.m. Cream in cans placed directly on the ice was cooled to 34 in the same period. Cream was kept perfectly sweet for 14 days in July, the hottest part of the summer. The cream was in small lots, varying from 20 to 25 pounds. The temperature in the pit an inch above the ice varied from 32 to 42.—U.S.D.A. Yearbook of Agriculture, 1931.

Engineered Dairy Production and Machinery

By A. W. Farrall[1]

THE dairy industry in this country has developed to the point where financially it now ranks first among the various branches of agriculture. The total value of the products of the dairy farm annually reaches $3,000,000,000. Most of this growth has taken place in the past thirty years, during which time the industry has changed from a simple one on the farm to a highly technical one, involving not only large and expensive producing units, but also elaborate processing plants and transportation facilities. The engineer in cooperation with the dairy technologists has been largely responsible for the results obtained.

The agricultural engineer has been primarily interested in that branch of the industry which deals with the production of milk on the farm, and we might mention as his first contribution that of improvement of stables, barns, and housing for the animals. The structures now being built for use on dairy farms, not only look after keeping the cow warm, but also make provision for proper ventilation and facilities for keeping the place clean. Many improvements have been made in the design of stanchions, gutters, feed troughs, and other accessories which go to improve the health of the animal and provide more sanitary quarters for her. At the same time much thought has been given to elimination of drudgery in the care of the animals.

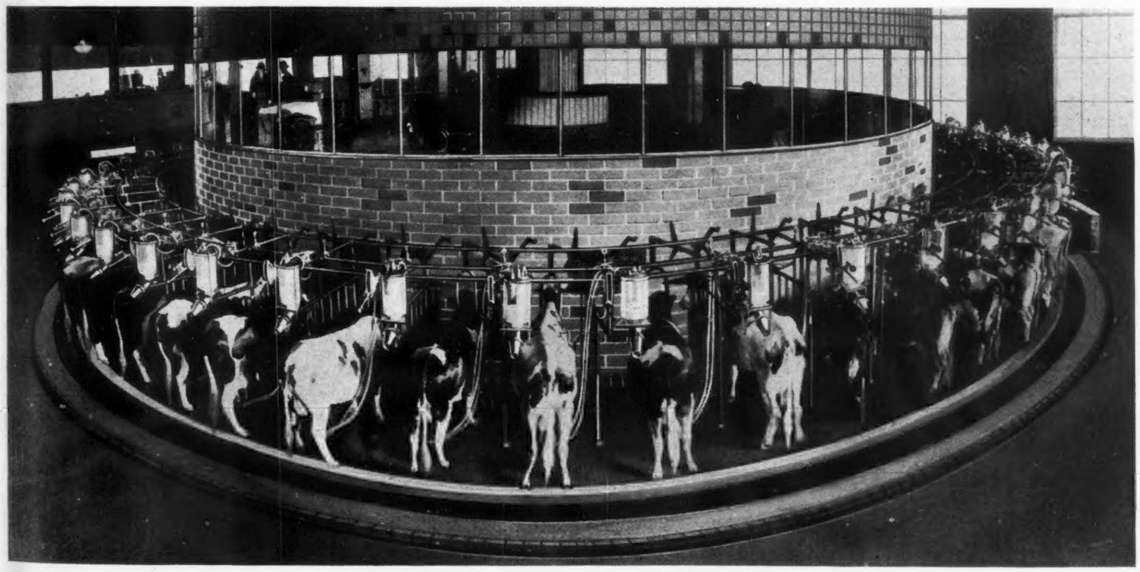
Water supply has been recognized as having considerable bearing upon the quality of milk produced. Newer installations provide plenty of clear cool water, not only for drinking purposes of the animals, but also for washing equipment and cleaning of the premises. The engineer has provided for gasoline-engine or electrically driven water systems which will economically supply an abundance of water, as compared to the old and laborious method of pumping water by hand or by windmill, in which was a tendency for the dairyman to skimp on the amount of water used to the detriment of the quality of milk and health of the animal.

Sterilization of dairy equipment and premises is now recognized as a necessity if quality milk is to be produced. The engineers and dairy technologists have supplied inexpensive and efficient sterilizers operating either through heat or the use of chemicals. Considerable progress has been made in the development of small steam sterilizers heated by a boiler, or by kerosene or electricity.

Refrigeration, practically unknown on the farm thirty years ago, except in those regions where cold water or natural ice were available, is now being looked upon as a requirement for the production of the highest quality of milk in many parts of the country. While much of the refrigeration is accomplished in receiving stations and dairy manufacturing plants, yet there is a growing tendency in the warmer sections of the country to refrigerate the milk on the farm by small electrically driven refrigeration plants. Numerous tests and investigations have shown that milk can be economically refrigerated on the farm.

The milking of cows has always been a chore which caused the farmer concern; not only was he dependent to a large extent on his milkers who were likely to leave him without notice, with a large number of cows to be milked, but the operation was expensive. A number of mechanical milking machines have been devised and thousands of individual units are in successful use every day. A milking machine is still not accepted by many dairy men; however, there is no doubt but what much progress has been made in the design and use of mechanical milkers, and they have given good service where one of correct design has been properly used. The most interesting and perhaps outstanding development along this line has been the "Roto-Lactor", which is a large rotating milking machine into which the cows pass one after the other and are carried to a certain point during which time they are washed,

[1]Director of experimental laboratory, Douthitt Engineering Company. Mem. A.S.A.E.



The rotary combine or "Roto-Lactor" installation on the Walker-Gordon certified milk farms at Plainsboro, New Jersey. It has a capacity of 50 cows and makes a complete revolution every 12½ minutes, in that time the cows being washed, dried and then milked. The process is continuous. The milk is weighed and flows directly to the milk room, the milking equipment being automatically sterilized after each milking. Two men are required to operate the equipment, and the milking time in man-minutes is reduced 95 per cent as compared to hand methods. The first cost is high, but with 1600 cows it is in use many hours per day

dried and milked. Then they are automatically allowed to leave the machine and another cow takes their place. This machine, built by one of the large eastern dairies which is engaged in the production of certified milk, has a capacity of more than 2,000 cows per day, and it combines the good features of mechanical milkers with a method of operation which makes milking operation almost entirely automatic.

The use of electricity on the farm has brought many conveniences to the dairyman such as lights, clippers, grinders, fiq traps, etc. Perhaps this one agency has and will contribute as much to lightening the burden of the dairy farmer as any other development. The only difficulty is that there are still many dairy farmers to whom electrical service is not available. It is the job of the electric power companies and other agencies to speed the day when all dairymen will have electrical power available at economical rates.

PROBLEMS OF THE IMMEDIATE FUTURE

The immediate problems which confront the dairyman have a bearing upon improvement of quality of dairy products, reduction in cost of the product, and the making of the dairyman more independent. The engineer thus has a wide field of activity to which he can contribute.

Improvement in quality is perhaps the most important problem at the present time, and in order to bring this about the engineer must design equipment which is simpler and more easily cleaned. He must develop refrigeration equipment that is less expensive and which can be purchased by even the smaller dairymen. He must also make available to the dairyman the results of tests and other data which show the advantages of refrigeration and other mechanical treatment. He can also assist in improving the quality of the product through the development of more simple and effective sterilizers which can be purchased at an economical price for use on the small dairy farm. Much attention has been given lately to the value of vitamins in the human diet, also the best means of making them available. Recent research at the University of Wisconsin seems to indicate that there is a possibilty of increasing the vitamin content of milk by feeding the cow on materials high in vitamin. The engineer thus has an opportunity to work out means for treating the feed of animals so that a high vitamin content is obtained in the milk.

Reduction in cost of milk appeals to dairymen, because other things being equal a lower unit cost means more profits. Here then is an opportunity for the engineer in cooperation with farm management specialists to develop efficient farm layouts which are properly balanced with the different size housing and production units. This covers not only buildings and equipment of that nature, but also feeding, watering, and cleaning systems. Is there any more reason why a dairyman should not feed his animals or clean out the barns by merely pushing a button than for the modern city man to raise the elevator in a tall building merely by pushing a button. It is true that all of these finer developments cannot be made available to a man who has only two or three cows. However, the tendency seems to be toward larger units, say, 12 to 50 cows, or even larger, where it is very likely that the size of the installation would justify a more elaborate system.

Transportation is another very vital problem having to do with reduction in cost of dairy products. There are today sections of the country in which the farmer pays as high as 40 cents per 100 pounds for milk selling at $1.50 per 100 pounds, merely for the cost of getting his milk to town. Certainly there is food for thought on the part of the engineer who is interested in increasing the profits of the dairy farmer.

One of the outstanding characteristics of the American farmer has been his comparative independence of existence. Some sociologists say that this has not been a good thing for him. On the other hand, there are those who attribute much of the progress of this country to the individualistic spirit of its people. Furthermore, the time has arrived when it is almost impossible for the American farmer to obtain reliable help at a reasonable price. In view of these facts, it seems desirable that the engineer assist the dairyman in every way possible to become independent of shifting day labor. This will be brought about through the use of labor-saving equipment such as self-feeders, mechanical milkers, and other devices which will increase the output per man. Then the producer can afford to hire a better class of workers and operate on a larger scale than under a system involving the use of a large number of low-priced day laborers.

Another immediate problem which the engineer should attack is that of improving the milk supply in the small towns. There has been a number of improvements made in machinery for enabling the small town to have a high quality pasteurized milk, and many such installations have been made. However, there are still hundreds of places which have not a satisfactory pasteurized milk supply, and the engineer should see to it that this condition is remedied.

The question is often asked as to just where the dividing line is between the engineering problems of dairy production and of dairy manufacturing. In many instances there is no exact line of demarcation, for in the case of the small town or city it is very likely that the man who produces the milk will have a small pasteurizing and bottling plant, and will even distribute the milk to the final customer. There is really very little manufacturing involved, and the specialized manufacturing equipment used is small in comparison to the production equipment used. There is no doubt but what this would all logically fall under a classification of agricultural equipment. In the larger areas of population, the industry has grown to the point where it has brought about a high degree of specialization. Here the fact that the milk is often several days old before it reaches the consumer, necessitates considerable processing with the use of a large amount of manufacturing equipment. Here, also, there are usually a number of manufactured products such as ice cream, cottage cheese, butter, and cultured milks. The result of all this is that most of our larger cities now have great milk-processing plants or factories involving the investment of millions of dollars. Their machinery is of a type which is much larger and more expensive than that used on the farm, and while some of it is based on the same principle as that used in the country, yet much of it is quite highly specialized. It seems then that the problems of dairy production and dairy manufacturing, while they are always quite closely related, in that they deal with the same raw product, and that they must work in harmony with each other, yet have quite a distinct line of demarcation in parts of the country where the dairy industry is carried on on a very large scale. On the other hand, in the smaller rural sections, the manufacturing problems, such as they are, are very closely tied up with those of production, and, if anything, are minor to the production problems. Certain problems are common to both production and manufacturing, such as sterilization, refrigeration, and transportation.

DAIRYING IN THE MODERN AGRICULTURAL COLLEGE

One point where the problems of production and manufacturing do meet is in the modern agricultural college. The college is interested in the product from the time it is produced until it is in the hands of the consumer; therefore, in one department or another practically every phase of its handling is considered. Here is an opportunity for the agricultural engineer to coordinate the efforts being made by the different departments along the line of engineering in the dairy industry. Some of these efforts may be sponsored by the agronomy, some by the animal husbandry, some by the dairy manufacturing, some by the economics, and some by the engineering departments. The proper coordination of the efforts of all these departments is necessary.

Artificial Dehydration of Forage Crops

By Harold T. Barr[1]

UNDER some conditions it has been found advisable to use artificial methods for curing forage crops. In the more humid climates heavy forage crops can be produced, but with natural curing processes from 30 to 60 per cent will be completely lost or lowered one or two grades by rainfall. In these same climates a yield of 2 tons per acre of good grade alfalfa, because of the high humidity, will require 5 days to cure properly. With field curing of hay a certain amount of leaves and fine stems are lost. This materially reduces the feeding value of the hay as the leaves contain a much larger proportion of minerals, protein, nitrogen-free extract and fat, and a smaller per cent of crude fiber. Some figures show losses of 300 pounds of leaves and fine stems per ton, and with less favorable handling losses of two or three times this amount. By bringing the green forage crop directly from the mower to the dehydrator, not only are all the leaves saved, but a more uniform green color is obtained in the finished product. The number of artificial dehydrators in the United States has increased very rapidly in the past year. There are about thirty forage-crop dehydrator installations in the United States today, the majority of which will be in productive operation this summer.

The first work in artificial dehydration was carried on by the U. S. Department of Agriculture from 1910 through 1912 at Hayti, Missouri. In 1911 Arthur J. Mason built an experimental dehydrator at West Point, Mississippi; he moved to the vicinity of Chicago three years later where he continued his work. The Bayley Blower Company, of Milwaukee, Wisconsin, in 1915 built a dehydrator for the McCracken Land Company of Houston, Texas. The Louisville Drying Machinery Company, of Louisville, Kentucky, started experimental work about 1915. From 1915 to 1925 there seemed to be little interest along this line, with about the only work going forward being that of Mason and the Louisville Company, each of whom were making improvements on their dehydrators. During 1925 the interest in dehydrators gained momentum and has been getting larger each year. The U. S. Department of Agriculture, state agricultural experiment stations, commercial companies and various individuals have each put forth considerable sums of money, time and effort in bringing about this development.

The dehydrators which have come into existence during this latter period are the Hero drier, the American Process drier, the Arthur W. Koon drier, the Randolph drier, the Fulmer drier, the Ardrier, the Louisiana State University drier, and a recent drier built on the U. S. Department of Agriculture Livestock Experiment farm at Jeanerette, Louisiana.

From the construction standpoint the dehydrators may be classified as of the (1) conveyor, (2) rotary drum, and (3) tray types.

The dehydrator used in the U. S. Department of Agriculture in 1910 was a conveyor type, in which the alfalfa was delivered by a conveyor to the top of a rectangular structure 20 feet high by 35 feet long (approximately). The hay was then passed back over a set of steam coils and dropped onto a second set of coils and taken to the front of the dehydrator. In this manner it passed over seven sets of coils, and thence to a storage barn. When using freshly cut alfalfa hay a capacity of 650 pounds of dry alfalfa hay per hour was obtained. These experiments brought out the facts that a large saving of leaves could be obtained by artificial dehydration and that a dehydrator would soon pay for itself in crops saved during unfavorable harvesting seasons.

The Mason, Bayley, and Fulmer dehydrators each utilize a conveyor for passing the material through a drying compartment or tunnel, approximately 150 feet long by 7 to 10 feet wide, where it is exposed to heated air or gases forced into the tunnel by a large fan from the furnace at a temperature of 300 degrees (Fahrenheit). The hay is formed into a fairly uniform mat on the conveyor, and the heated air is forced up and down through it by suitable baffles in the tunnel. This type drier has a rather large horsepower requirement, can be adapted to most any fuel and turns out a good product.

The American, Ardrier, Hero, and Louisiana State University dehydrators are of the revolving drum type, each having certain definite characteristics. With this type the hay is cut into short lengths, charged into the hot end of the drum where it comes in contact with the hot gases (1000 to 1600 degrees). Shelves on the interior of the drum agitate the hay, and as the moisture is driven off, the hay is worked to the outlet end. This type of drier has a fairly low horsepower requirement, is reasonable in initial cost, and yields a good product.

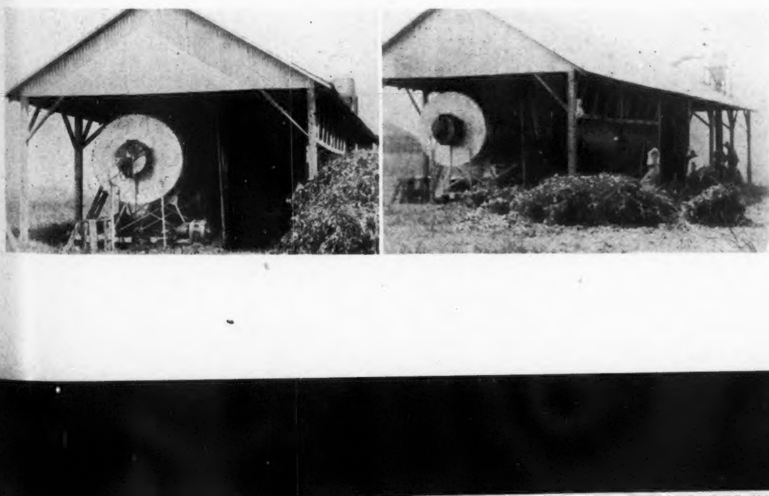
The Louisville drier originally was a rotary drum with steam coils for furnishing heat. It has recently been changed over to a tray type drier, but the company will continue to build either type.

In addition to the Louisville Company, the Randolph Dryer Company has made two tray-type driers. In this type the hay is placed in large trays with perforated bottoms and passed down through a drier chamber which receives hot gases from a furnace. No material has been released on tests of these driers and their possibilities are yet to be determined.

The first method of applying heat for driving off the moisture was an indirect method, in that heat was stored up as steam and thus transferred through pipes and condensed, giving up heat to the hay. A little later it was discovered that furnace gases mixed with air had no harmful effect on the hay and a much better thermal efficiency. A recent practice is to use the undiluted furnace gases with as little excess air as possible and thus get still better efficiency.

The type of dehydrator will to a great extent determine the relative temperature of air that may be used. In working with a dehydrator which is being operated this season, as high as 1800 degrees was maintained on the inlet end and 230 degrees on the outlet end without any harmful effect upon the hay. It would seem that some

[1]Assistant professor of agricultural engineering, Louisiana State University. Assoc. Mem. A.S.A.E.



Two views of the rotary drum forage drier used for experimental purposes at the Louisiana State University

very careful studies should be made upon increasing efficiencies by using higher temperatures.

In the opposed current drier, where the highest furnace gas temperatures come in contact with the driest hay, the temperature of the hay almost reaches that of the entering air and may decrease the digestibility of the protein with high temperatures. With the parallel current drier which may be operating under a slight vacuum, the hay never reaches a temperature above 212 degrees and cools off rapidly in giving up its moisture. The leaves and stems move through an opposed current drier at the same rate, with possibilities of overdrying the most valuable part of the hay, if the stems are sufficiently dried, while in a parallel current drier the leaves will pass out more rapidly than the stems and thus dry all the material to a uniform dryness.

Instead of studying all the fundamental requirements of a forage crop dehydrator and then designing a machine for this purpose, the pioneer work in this field was done by actually building machines with general ideas as to what they should do. The various fundamental factors are gradually being worked out and these various dehydrators improved.

In the future agricultural engineers doing research in dehydration should work with the plant physiologists in determining the forage plant structure and how it gives up moisture in curing. In cooperation with the animal husbandryman and the chemist, the feeding value of the various plants will be tested by laboratory methods and by actual feeding trials. The agronomist may aid in suggesting plants which yield heavy tonnage, but are not in wide usage today because of difficulty encountered in curing by natural methods. The proper curing of the crop after it is delivered to the dehydrator is only part of the problem that must be economically and successfully solved. More improved field machinery and methods than are now in use must be worked out in order to lower the cost of delivering the green material to the drier.

After the hay is cured, then how it is to be handled is another problem. Should this material be reduced to a meal, baled, sacked, mixed with molasses, blown loose into a large storage barn, or compressed into cubes? Cattle feed in cube form may seem rather unnecessary, but is under trial in England and is being considered by a large dairy in the United States.

Mechanization of Cotton Production

By H. P. Smith[1]

THE year 1621 is generally regarded as the birth year of cotton culture in the United States. For almost two centuries the cultivation of cotton was limited to such quantities as were needed for domestic use, since the cost of "hand ginning" usually exceeded the value of the cotton thus ginned. It can be safely said that the first step in the mechanization of cotton production began with the preparation of the fiber for the market, and was the invention of the cotton gin by Eli Whitney in 1794. The discovery of an effective method of separating the lint from the seed gave cotton culture an amazing impetus.

Within six years after the invention of the cotton gin, the production of cotton increased from 5,000,000 to 35,000,000 pounds annually. From 1810 to 1845 the amount increased from 85,000,000 to 1,029,850,000 pounds annually. Even though the quantity of cotton produced continued to increase as the years passed, it was not until 1874 that any significant step in the improvement of field machinery occurred. In that year the Dow Law planter was put on the market. This planter was capable of opening a furrow, dropping the cottonseed into it, and covering them, all in the same operation. Joseph B. Lyman, in his book "Cotton Culture," published in 1868, lists the following equipment necessary to grow 100 acres of cotton: Five heavy plows for preparing the land; eight or more small plows for cultivation; three or four light harrows, and ten hoes.

During the past 60 years great progress has been made in the improvement of field machinery for cotton production. It is true that we still find primitive methods being used on many of the small cotton farms, but the progressive farmer now has the choice of up-to-date equipment to perform most all his field operations. The various operations necessary in the production of a cotton crop are: (1) Disposal of the stalks from the past year's crop, (2) preparation of the seedbed, (3) distribution of fertilizer, (4) planting, (5) thinning of the plants, (6) cultivation, (7) dusting for insect control, (8) harvesting, and (9) ginning—preparation for the market. All of these operations can be performed in a satisfactory manner mechanically, except the thinning of the plants and the harvesting of the cotton.

A brief review of the equipment available for each step in the production of the cotton crop will show the mechanical status.

In the disposal of the past year's stalks, stalk cutters are available, which will cut the stalks in short lengths by pressing them against the ground. Other machines that are being experimented with, chop the stalk up by semi-vertical cylinders of short knives carried on and driven by a tractor.

The old double shovel and the Georgia stock with half shovel which have been the principal tools for preparing the seedbed are rapidly being replaced by one and two-row horse-drawn middle breakers or listers, and in many instances by two, three, and four-row tractor-drawn middle breakers or listers.

Planting equipment has passed from the Dow Law planter to the modern two-row horse-drawn planter, and the four-row tractor planter, where 30 to 40 acres can be planted in a 10-hour day.

The old method of "putting out" fertilizer for cotton was to carry a bucket full along the row and distribute it by hand, a tiresome and laborious method. Now the fertilizer can be applied mechanically, either before planting, at the time of planting, or as a side dressing after planting, as the farmer may desire.

One of the missing links in the mechanization of cotton production is the thinning or chopping out of the plants. Many machines have been invented for this purpose, but they lack the human element to select and leave the plants which appear to be more promising.

Under cultivating tools, one may still find a few isolated places using the Georgia stock, with "bull tongue" and "heel sweep", but now the modern equipment consists of one and two-row riding horse-drawn cultivators and of two and four-row tractor cultivators.

Equipment for the control of insects, especially the boll weevil, ranges from the primitive bag and pole method of distributing poisons to the one-row and multiple-row power dusters and even the modern airplane, by means of which dust poisons can be applied at the rate of 100 acres in 10 minutes.

Harvesting of the cotton crop is another missing link in the mechanization of cotton production. Millions of men, women and children of all races are employed each year from July to October in harvesting the cotton crop. But we hope to fill this link in the near future, since mechan-

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Cotton cultivation and dusting in the large-scale, low-cost production areas of Texas

ical harvesters of both the stripper and picker types are being rapidly perfected.

The preparation of the cotton for the market, or ginning, is the most specialized and industrial step in the production of cotton before it reaches the spinning mills. Ginneries range all the way from the crude out-of-date one or two-stand outfits to one having ten or fifteen arranged in batteries of five stands each, and the entire plant costing as much as $125,000. Ginners have the choice of selecting either a brush or air-blast gin equipped with or without cleaners, and operated by steam, Diesel engine, or electric power.

Even though we have made considerable progress in the improvement of mechanical devices for performing the various operations necessary in the production of the cotton crop, still there is need for a great many improvements, some of which are as follows:

1. A machine to chop or grind cotton stalks so that they may be worked into the soil without interfering with succeeding crops
2. A study of cotton planters to determine the best type of dropping device for cottonseed (both fuzzy and delinted), the best type of furrow opener, and the best type of covering device.
3. The development of a cotton planter suitable for irrigated sections
4. A study of cotton planting methods to determine the relative merits of planting level, on the ridge, and in the listed furrow below the level
5. The development of equipment for delinting cottonseed for planting purposes
6. An accurate and uniform fertilizer distributor that can be used as an attachment on the planter and will place the fertilizer at any point desired in relation to the seed
7. The development of a system of planting to eliminate the necessity for the thinning of cotton plants
8. A study of cultivating equipment to determine the best type of cultivator shovel or sweep to use
9. The development of a simple, low-priced, mechanical harvester
10. The development of varieties of cotton suitable for mechanical harvesting
11. The development of cotton-cleaning machinery that will give a sample practically equal to that of hand-picked cotton
12. A study of ginning equipment to determine optimum saw speed, optimum density of gin roll, best method of moting, best saw construction, and the effect of cleaning equipment on grade and staple.

The Farm Engine Fuel Situation

By C. G. Krieger, Jr.[1]

POWER is, and always has been, the cornerstone of the great agricultural structure. In the early days that cornerstone was man power. Animal power succeeded man power, and about fifty years ago mechanical power appeared on the farm.

The types of mechanical power on the farm today were practically in their infancy at the outbreak of the World War. Agriculture, among the great fundamental industries, was the last to receive the benefits of mechanical power, and is still in a period of adjustment to its application. The 200,000 tractors that are now being produced annually give great promise that, in the future, agriculture will enjoy the same benefits of inexpensive power that industry in general accepts as a matter of course.

The tractor is the keystone of power farming, and the internal-combustion engine is the foundation of the tractor. Motor fuel is the basic source of power for the internal-combustion engine.

The modern type tractor had its inception about 1907. At that time there was a large demand for kerosene for illuminating purposes, and this relatively cheap product was available at every cross-roads store in the country. On the other hand, there was little demand for gasoline; it was expensive and was available only in isolated, populous sections. It was only natural that tractor engineers at that time should design engines to operate on kerosene, for it was the only fuel that would be available for the use of the farmer. Today we find that relatively few changes have been made in the engines used in tractors. They have been improved from time to time, but still remain kerosene type engines.

There can be no doubt as to the economy of kerosene-burning engines, when the cost of kerosene is much cheaper than that of gasoline. However, due to the phenomenal growth of the automobile industry, with a resulting rapid rise in the demand for gasoline, the ratio of supply and demand for kerosene and gasoline has been reversed. In order to meet the ever-increasing demand for gasoline, the petroleum industry has had to devise ways and means of securing a greater yield of gasoline from a given quantity of crude oil. The cracking process has been mainly responsible for the development of greater

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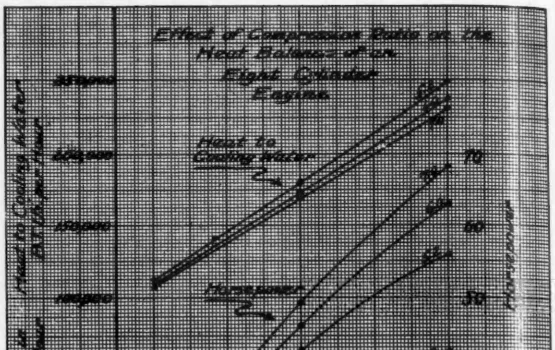
yields of gasoline. More and more kerosene and gas-oil has been cracked into gasoline, with the result that the price differential between kerosene and gasoline has decreased to such an extent that, in most parts of the country today, gasoline is actually cheaper than kerosene, not counting the road tax on gasoline, although many states give a tax refund on gasoline used in tractor engines.

The question arises as to whether it is still economically practical to use kerosene as a motor fuel for tractors. In recent years very little research has been done to determine just what is the optimum fuel for use in tractor engines, and it has become necessary to start research in this field. There has recently been organized the Committee on Fuels and Lubricants of the American Society of Agricultural Engineers, to undertake a study to determine the most economical fuels and oils for use in tractors and in other farm engines. This committee is composed of representative engineers from the tractor manufacturers, the federal department of agriculture, and the automotive and petroleum industries, and it is cooperating with the Society of Automotive Engineers and other similar agencies in order to avail itself of the engineering experience of the automotive industry, thus eliminating duplication of effort.

The trend in the automobile, motor truck, and aeronautical industries is quite definitely toward high-compression engines and anti-knock fuels, which make the use of these more efficient engines possible. The time is not yet at hand when any definite statement can be made as to the trend in the tractor industry. Sufficient work has not been done in the tractor field to establish any positive facts. It is believed that eventually all tractors will be designed to operate on good quality gasoline, because of the many advantages of gasoline over kerosene, and also because of the many disadvantages in the use of kerosene.

One of the most important problems confronting the agricultural engineer today is the economical production of power. Fuel is the basis of power, and engine design and fuel design are so closely related that they can be called aspects of the same principle. In the formula for the determination of performance and economy, it is apparent that a given engine of specific design operating under the proper conditions will be a "constant," and the "variable" in the case will be the kind of fuel used. There is a very wide degree of difference in the amount of power that can be developed from different fuels. The power and economy of an engine are almost direct functions of the compression ratio which is employed. The accompanying set of curves showe the effect of compression ratio on the heat balance of a typical eight-cylinder engine. While these particular curves were obtained from an eight-cylinder engine, the same relative results will hold true for other engines regardless of the number of cylinders.

Quite a large number of experimental automobiles with engines having as high as 7-to-1 compression ratio are operating very satisfactorily today. These cars give phenomenal performance and economy, but will operate on good quality anti-knock fuel only. The average compression ratio for all 1931 automobiles is 5.2 to 1, and the ratios



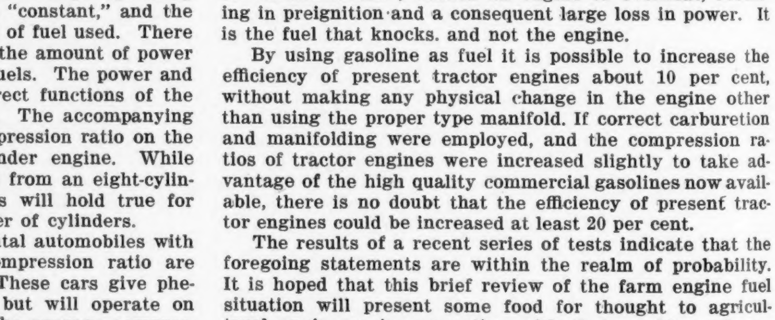
have a steady upward trend, most manufacturers offering optional high-compression heads at no extra cost.

The average compression ratio of current production tractors is only 4 to 1. This ratio is the highest that can be used satisfactorily with kerosene as fuel. Beyond this point severe detonation occurs with kerosene. Detonation (quite often erroneously referred to as "spark knock" or "carbon knock") causes an engine to overheat, resulting in preignition and a consequent large loss in power. It is the fuel that knocks. and not the engine.

By using gasoline as fuel it is possible to increase the efficiency of present tractor engines about 10 per cent, without making any physical change in the engine other than using the proper type manifold. If correct carburetion and manifolding were employed, and the compression ratios of tractor engines were increased slightly to take advantage of the high quality commercial gasolines now available, there is no doubt that the efficiency of present tractor engines could be increased at least 20 per cent.

The results of a recent series of tests indicate that the foregoing statements are within the realm of probability. It is hoped that this brief review of the farm engine fuel situation will present some food for thought to agricultural engineers in connection with their problem of producing more economical power for agriculture.

A two-row corn picker mounted on a general-purpose tractor and operated by its power take-off. The wagon into which the corn is elevated is pulled from the center of the draw-bar, without side draft



The Engineer's Obligation in Meeting Agricultural Competition

By Arnold P. Yerkes[1]

PEASANT farming in Europe was relatively prosperous until about the middle of the nineteenth century, when American farmers began shipping machine-harvested wheat from the cheap, fertile prairie soils of our Middle West and offering it on the European markets at prices, which were ruinous to peasants farming high-priced land with hand implements which had not been improved since the days of Pharaoh.

This competition dealt a blow to peasant farmers and European farm land values from which they have never recovered. Hundreds of thousands of European peasants emigrated to the United States, obtained free land, purchased on time the labor-saving equipment then available, and helped swell the flood of farm products which poured from the United States into the world's markets, and brought a wealth of gold in return.

Under this competition, profits of peasant farmers in many other countries dwindled and their land values shrank, while the American farmers prospered and their farm lands mounted in value.

For years, so long as American farmers produced their crops at lower costs than farmers in other countries, enormous surpluses were disposed of at highly satisfactory profits. But for the past few years, and especially during the past decade, large tracts of virgin land have been broken in other countries and farmed with the most modern equipment—equipment equal to that employed by the most efficient American farmers and far superior to that still used by many who have failed to keep pace with the recent developments in labor-saving farm machines.

This competition has been far stronger than any which American farmers ever before faced. It has brought low prices, a tremendous drop in farm land values, the loss of a large part of the world's markets, and has necessitated high tariffs to hold even our domestic market for the American farmer.

We may well ask if it is possible for American agriculture to withstand this competition. While it will not be easy, it can be done.

A prerequisite for successful competition in farming, as in any other productive enterprise, is a low production cost. This fundamental fact, though seemingly self-evident, has been slow in receiving general recognition.

To produce farm crops at low cost requires, primarily, a fertile soil, a minimum of man labor, and cheap power effectively applied.

Low-cost production, on which entirely depends the success of the individual farmer and of our national agricultural industry as a whole, therefore lies very largely within the field of the agricultural engineer, for the maintenance of a fertile soil, efficiency in the use of man labor, and the most effective application of an economical form of power can be fully attained only by utilizing the principles of the science of agricultural engineering.

Sales of Farm Machinery in the United States	
1922	$222,907,000
1923	311,976,000
1924	277,924,000
1925	340,271,000
1926	364,751,000
1927	391,868,000
1928	402,872,000
1929	458,521,000

Exports of Farm Machinery from the United States	
1922	$ 23,924,000
1923	50,570,000
1924	59,824,000
1925	77,354,000
1926	85,500,000
1927	90,747,000
1928	116,651,000
1929	140,801,000

The fertile topsoil which formerly covered most of the United States, and which took Nature hundreds of years to produce, has already been largely lost through erosion. To retain the remainder and to create and retain a substitute for that washed away, will require the general use of methods and practices quite fully developed by the agricultural engineer, but still largely unknown or unappreciated by the individual farmer.

That American agriculture can continue for the next fifty years to lose its soil—the very foundation upon which it rests—at the rate it has been losing it for the past half century, and still be able to compete successfully against the agriculture of countries with large areas of practically virgin soils, seems impossible.

To save our remaining topsoil, then, and to create and make permanent a new topsoil to replace that washed away, in order that the American agriculture of the future may be able to supply our national needs, to say nothing of supplying part of the world markets, and do so profitably in competition with the products of the agricultural industries of other countries, is a premier and challenging obligation of the agricultural engineer, and one which will demand his utmost efforts toward the desired goal.

But of equal, if not greater, importance is the task of increasing the efficiency of those thousands of American farmers whose costs are still relatively high. Every study made of farm production costs has shown that there is a tremendous variation in the cost of producing any crop on different farms even when soil and climatic conditions are similar. The greatest cause for these large variations is difference in the efficiency with which labor and power are utilized—in other words, difference in the character of equipment employed.

These variations in costs are far greater than are found in any other industry or which could exist in any other industry. In other lines, high-cost producers are quickly forced out of business. Were it not for the fact that farmers obtain a large part of their food from their own farms, and hence can exist and continue in business in a fashion even without profit, this would be true in farming. But though high-cost farmers are not readily forced to quit, they inevitably suffer. They can no more compete successfully against low-cost producers in this country or other countries than can high-cost producers in other lines.

That with proper equipment and organization staple farm crops can be produced in the United States as cheap or cheaper than anywhere else in the world is being demonstrated on numerous farms. That such results can be duplicated on a large percentage of our farms is obvious. That this must be done if the operators of these farms are to compete successfully against the low-cost producers in this country and elsewhere seems almost equally obvious.

Tremendous improvements have been made in farm equipment during the past quarter-century, largely through the efforts of agricultural engineers. But its adoption by American farmers has not kept pace with its development and the statistics show it has been adopted more rapidly, relatively, by the American farmers' competitors during the past decade than by American farmers.

The danger of this situation is written large in the pages of history and is shown plainly by our present agricultural distress. The remedy is known to the agricultural engineer. Its application offers him an opportunity of rendering so great a service to American agriculture as to make it appear an obligation.

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[1]Editor, "Tractor Farming," International Harvester Company. Mem. A.S.A.E.

Mechanics of European Corn Borer Control

By R. B. Gray[1]

THE hope of effectively controlling the European corn borer appears, at present at least, to lie chiefly in the use of machinery. Because of the peculiar habits of the pest, ways and means for successfully combatting it in the growing crop have not as yet been worked out. The control measures must, therefore, be applied during or after harvest.

Due to differences in methods of harvesting the corn crop in the western infestation area, control measures must be varied accordingly. The entomologists have determined that covering infested cornstalks completely by plowing is a satisfactory control measure. Effective plowing, however, requires that plows adapted to the soil, and of 14-inch width or wider, be used; that they be carefully adjusted and operated; that they be equipped with standard corn-borer control attachments, such as large rolling coulters, jointers, and trash wires; and that the plowing approach 6 to 8 inches in depth so that subsequent tillage or seeding operations will not expose trash previously buried.

Some two thousand tests with nearly sixty plows (the majority loaned by manufacturers), covering a period of four years in the Toledo (Ohio) area, have brought out many valuable correlations particularly as to width of plow, depth of plowing, speed of plowing, beam clearances, soil type and condition, and shape of plow. In general, it was found that the wider plows give slightly better coverage, that depths from 6 to 8 inches are best, and that the higher speed of a two-speed tractor gives the more satisfactory results. Plows with the larger beam clearances perform best, and soils in favorable physical condition permitted of vastly better trash coverage.

As clean plowing is so dependent on suitable plow attachments, extensive experimental work has been devoted to this phase of the problem and has developed several unique devices of more or less merit, the most promising of which are the floating trash shield and the floating coulter. The former floats on the surface of the turning furrow and scrapes the trash into the furrow-sole opening. The floating coulter operates under slight spring pressure and is particularly useful when plowing in stony land.

The area of standing-stalk land which is not to be plowed, presents quite another important control problem. However, by cutting the stalks off close to the ground and destroying or otherwise treating them, the greater part of the borers may be killed. For removing the stalks two types of stalk shavers have been developed. One consists of a sled shaver fitted with two diagonal knives, and is capable of cutting two rows at one time. When two shavers are hitched abreast four rows may be cut simultaneously. The other type consists of an attachment for one and two-row corn cultivators. With the one-row cultivator and its shaving attachment, three rows are shaved at one time; with the two-row machine and its attachment, four rows are cut. The attachments have been made universal so that they are adaptable for use as three-row shavers on the popular single-row cultivators of six manufacturers, and as four-row attachments on the two-row cultivators of two manufacturers.

After shaving the stalks it is necessary to rake them into windrows for burning or removal from the field. To facilitate this operation the four-bar, side-delivery rake was developed. These machines will rake hay equally well.

Ordinarily, for borer control the stalks would be burned in the windrows. However, because of the probable increase in the use of the stalks for processing, more economical means of removing them from the field than are now available are necessary. Reconstructed hay loaders have given some promise, as have so-called pick-up devices, and these are to be studied further. A unique combination machine, which according to a preliminary performance gives promise, is a two-row machine consisting of an elongated four-bar side rake under the frame of which are mounted two shaver blades. A pick-up device is attached to the rear on the stalk-delivery side to deliver into a wagon or truck.

When the corn is to be ensiled or shocked the control problem is somewhat simpler. It is known that few borers exist in the corn plant below the ground. Therefore, by harvesting with a binder fitted with a stationary-knife, low-cutting attachment the fodder may be cut level with the ground, permitting the removal of most of the borers in the stalks. Then in passing the fodder through the ensilage cutter or husker-shredder a high mortality is effected. Such attachments are now available for all the vertical binders made in the United States. A similar low-cutting attachment has been developed for the ensilage harvester, as has also a low-cutting hand hoe for the surface cutting of stalks to be hand-harvested.

In addition to the tools cited above certain other machines give indications of being likely control weapons. The mechanical corn picker the use of which is rapidly extending, is adapted to the attachment of a set of stalk-

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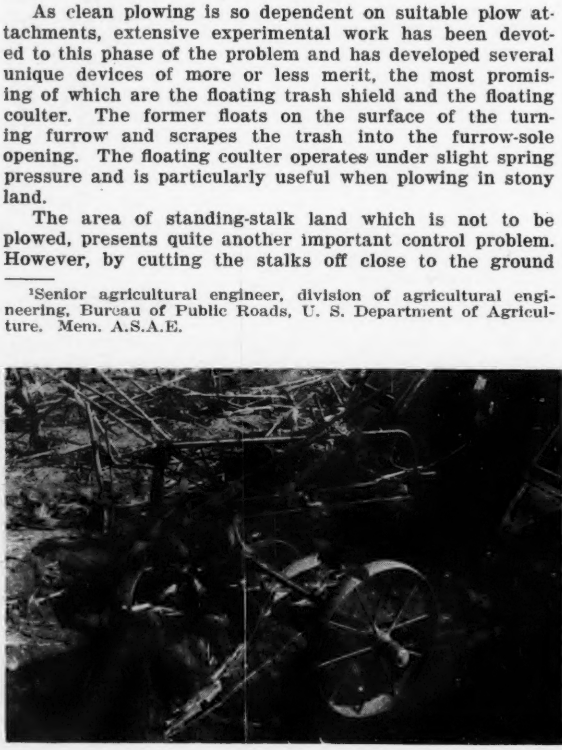

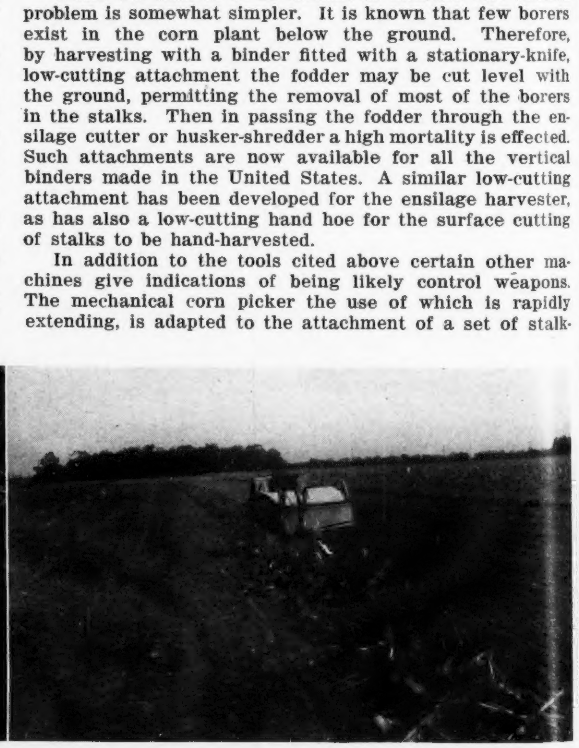

(Left) A plow equipped with standard corn borer control attachments. (Right) A four-bar side rake that is proving highly efficient

crushing rolls or a shredder head, to mutilate the stalks as the corn is picked. Some work has been done along this line with gratifying results.

The corn "combine" presents another likely medium of attack. By cutting the stalks close to the ground and shredding them as the corn is picked and shelled, excellent control could undoubtedly be accomplished.

A simpler machine, similar in principle to the ensilage harvester, for chopping the stalks after the corn has been handpicked, may be a desirable tool. A start has been made on this.

When stalks in a field are badly down, many are missed by the binder, picker, or combine. By adapting the so-called lifting-finger attachment practically no stalks would be missed. Tests of this attachment on several different machines have indicated considerable promise.

In the eastern infestation area, sweet corn suffers much damage from ravages of the European corn borer. Experimental work by the entomologists in the application of insecticides indicates a possible means of control in the growing crop. Machinery for the effective application may, however, be the limiting factor. Here is another opportunity for the ingenuity of the agricultural engineer.

Cooperative machinery investigations have been inaugurated in several states in or near the western infestation, as well as in the eastern or New England area. Manufacturers are cooperationg as well as many farmers. The Bureau of Public Roads, the Bureau of Entomology, and the Plant Quarantine and Control Administration of the U. S. Department of Agriculture, are closely associated in the work. As conditions in New England present radically different problems special work is under way there. With the continued hearty cooperation of all agencies concerned, the outlook for ultimate control of the pest by mechanical means seems promising.

Principles of Deep Tillage

By O. W. Sjogren[1]

THE tillage operations which man has practiced for thousands of years have been concerned practically entirely with the upper few inches of the soil.

Soil conditions vary so greatly that no one tillage practice is applicable to all soils, nor at all times to the same soil. Because of these differences in soil conditions, tillage requirements also differ. Many tillage practices have arisen as knowledge has been acquired regarding plant requirements and the behaviour of different soil types, and as progress has been made in the design and manufacture of implements.

In regions where rainfall is seasonal, some soils become very hard during the dry season, and are most difficult to work. The nature of such soils is generally such that as they dry out they become cement like. Other soils may be of the adobe or other tight types into which water does not readily enter. The first rain that falls as the wet season approaches is lost, because it cannot penetrate until the soil has become somewhat softened and it requires considerable time for such soil to become thoroughly softened. The consequence is the loss of a great deal of the moisture which should go into the soil to be held for crop growth during the growing season.

Tight soils are also found in the more arid areas, and they are constantly being made thus through improper working. The continual plowing and otherwise working the soil when rather moist, at a constant depth year after year, causes the furrow bottom to become much like a cemented layer. After a period of years this layer becomes of such thickness and density that it acts as a very active retardent to water and root penetration. This results not only in loss of water which should be held in the soil available for plant growth later in the season, but plant growth is retarded and the erosion problem is intensified. The water will readily penetrate through the surface layer. When it strikes this hard layer or plow pan, its downward travel is retarded, and if the rainfall is considerable it will flood this surface soil down the slope thus increasing erosion.

The formation of this layer is not confined to the heavier or clay soils, but it is very frequently found in sandy loam soils where its presence is least suspected. In some soils there is a natural pan or compact layer varying in thickness and at various depths. When this layer is near the surface, the effects are the same as from the plow pan.

It is not difficult to realize what would happen, if we would cover a concrete road with a few inches of good soil and then attempt to farm it. The first year or two we might secure a good return from a shallow-rooted crop, but if we would plant trees or other crops which have a deep-growing root system, we would not get very far. This is quite comparable to the conditions which exist in a soil with a decided hard pan or plow pan. The only difference is that the concrete would not soften up by being continuously moist, while the plow pan might eventually permit water to go through it, if it would stand on it long

[1]Agricultural engineer, Killefer Mfg. Corporation. Mem. A.S.A.E.

(Left) A chisel working up stubble ground, covering a 5-foot strip and penetrating to a depth of 12 inches. (Right) Disking in corn and oat stubble after pan breaking, preparatory to planting wheat

(Left) A pan-breaker loosening hard soil to a depth of 18 inches. (Right) A cover crop disk harrow working-in a heavy crop of vegetation. The vegetation is distributed through the soil instead of being left in a thick layer

enough. The moisture penetration will, however, be extremely slow. While this penetration is taking place, there is great loss from surface drainage and evaporation, but the dense layer is still there to interfere with normal root growth and with rapid penetration of water.

Roots will make good growth through the soil to find supplies of plant food, if they can proceed normally. If they encounter hard formations their growth is slowed down, and the plant becomes stunted and sickly.

Deep tillage consists of breaking up these hard soils and hard layers by mechanical means. The greater power of the tractor as compared with the power available from animals will enable one to pull much sturdier tools through the ground at depths sufficient to break and stir the hard substrata of soil without turning it to the surface. As these hard layers are broken up, the hard lumps are left under ground where they are best acted upon by moisture conditions surrounding them and are not brought to the surface to dry out and bake into hard clods and interfere with the proper conditioning of the surface soil.

The idea of deeper stirring of the soil without turning it over was first practiced in California on a large scale through the efforts of John Killefer. This system of deep tillage makes use of three principal tools: a heavy pan breaker, a chisel or deep cultivator, and an especially designed cover-crop disk harrow with large diameter disks with wide spacing between disks which are of greater than ordinary concavity.

This breaking up of the hard soil carries with it many advantages, one of the principal ones being to allow water to enter quickly and easily so that it can be stored to protect the crop against dry weather later in the season. If the soil is loose or free to a considerable depth, all the water falling upon it will seep downward until each soil grain has taken up its own portion of the water. It will then remain stationary until the supply at hand is exhausted. Since it is only the tips of the roots that can take up moisture, and since plant food must be dissolved in water before it can enter the root system, it is essential that the soil be prepared so that it can receive this water freely and store it so that the roots can proceed to a new supply easily and quickly.

The soil should be in such physical condition as to receive the moisture readily as it is not desired to have the water run horizontally from the surface of the land. Horizontal water carries with it soil grains and soluble plant food, and often causes serious gullying and soil washing which damages the land physically. The increased water-receiving ability of the soil is of particular importance in regions of scant rainfall where every drop should be preserved for the use of the plant later when the rainfall may be scant or entirely fail. Where irrigation is practiced, fewer irrigations are necessary since the water penetrates better.

This washing often takes good soil into the nearest river and frequently carries off poor soil to deposit it upon better land. Soil should be in such physical condition that water can move in it vertically rather than horizontally. If water cannot penetrate downward, it will fill the top soil and cause water logging, bringing about an acid condition detrimental to crops and also result in surface baking. It also kills the beneficial air-needing soil bacteria and drys out the soil air thus depriving the roots of the necessary oxygen.

Another very important advantage of this system of tillage is that the soil can be stirred deep without bringing to the surface the soil that should stay below. The greatest quantity of soil life is found in the upper 6 or 8 inches of soil. This layer of soil is left on top where it belongs and the bacterial life is least interfered with.

Vegetation is worked into the soil by means of the cover-crop disk harrow, rather than being merely turned under and left in a thick layer, as is done in plowing, which requires considerable time to become a part of the soil.

Some may contend that there are natural methods of breaking up those hard soils which will prove sufficiently effective, such as plant roots, earth worms, freezing and soil cracking. These are all more or less effective but are too slow in action.

This system of deep tillage is not recommended as a panacea for all soil problems. Like everything else it must be used with intelligence and with reason. A soil that is naturally loose to a considerable depth can receive no benefit from working it deep.

One must know the soil in order to know what tillage practice would be most desirable. The time of the year is also very important, and for best results deep tillage should be done at a time when the soil is dry so as to make the shattering as thorough as possible. If used in orchards, vineyards, and in other crops where the plants do not die down each year, the deep working should be done at the time of the year when the plant is dormant in order not to interfere with the development of the plant in its active stage.

As this system has become better known, it has been successfully adapted to practically all crops of orchard, field and garden, and has been introduced into every continent on the globe. This progress has not been based on high-pressure propaganda methods but merely upon the spreading of the information as to results secured.

This tillage system lends itself very readily to a program of reduction in production costs. Inasmuch as the soil is merely loosened, and not turned over, a greater width of chisel can be pulled and at a greater depth with a given amount of power than is possible with a plow. The soil is first loosened with the pan breaker or chisel. This means more land covered in a given length of time. The cover-crop disk harrow will complete the work of seedbed preparation. This work is done in a thorough, rapid and effective manner, at the same time keeping the cost of seedbed preparation to a minimum.

Engineering Requirements of Rural Fire-Fighting Equipment

By J. P. Fairbank[1]

THE subject of rural fire-fighting equipment includes devices useful for the suppression of fires which involve structures and equipment; grass and grain; forest and brush. Much apparatus is required to be of general-purpose utility, but some must meet specific needs.

Fire apparatus has been developed to a high state of perfection to meet urban requirements, the result of a wealth of information gained from many years of practice and experimentation. The demand for city fire-fighting equipment has been of sufficient magnitude to encourage competitive commercial activity in its manufacture and improvement. The fund of information on the requirements of rural areas is meager.

The insurance companies can tell definitely what has been the percentage of loss on their rural business, but there is little data based on long years of experience to indicate the true value of rural fire-fighting equipment and organization. However, the accumulation of local experience assures us that equipment selected and used with good judgment has, in the aggregate, prevented potential fire losses far in excess of the investment. More complete rural fire reports available to all agencies concerned are essential to aid good judgment in the selection and development of equipment.

Dependability is the outstanding requirement of all fire apparatus. The hand fire extinguisher which fails to function at the critical moment, or the engine which refuses to start are not fire safeguards but fire-hazards instead, because time lost in trying to operate them might be used for some other method of attack. Dependability with simplicity is especially desirable for rural fire-fighting equipment because of the conditions under which it is likely to be kept and used. Since inspection and maintenance may be lax, and the use of the equipment an unusual event, rather than the every-day work of the city fireman, dependability is promoted by simplicity in construction, maintenance and operation. The achievement of dependability requires not only careful attention to design and materials, but also ability to foresee human behavior during the excitement which accompanies a fire. The term "foolproof" is homely and trite, but it aptly describes a desirable feature of rural fire-fighting equipment.

Suitability of equipment is a requirement of outstanding importance and one which involves many factors, indicated by such questions as:

How large an area is included?
Is the protection for a village, farmsteads only, or both?

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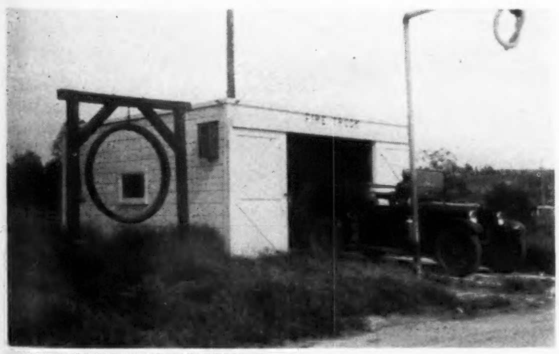

Fire protection equipment of a small rural community

What property values are involved?
Who will maintain and operate the apparatus?
What is the situation as to water supply?
What are the climatic conditions?
What is the nature of the roads?
Where will the equipment be stationed?
What is the method of alarm?
What funds will be available for purchase and maintenance?

The last question may seem beside the point, but it is a most potent factor in determining what can be done. Restricted finances may dictate that small units be added from year to year, rather than a large and costly single installation beyond the limitations of the current budget.

For the protection of structures in rural areas some types of urban fire apparatus may be suitable, but usually they must be modified as to capacity, equipment and mobility. Lack of adequate water supply on farms and in villages is a common situation; therefore, large pumpers may be useless. Chemical engines as developed for city service have proved adaptable to rural use, but now "tank pumpers" are better meeting the requirements. By "tank pumper" is meant a motor truck carrying a tank of water and a pressure pump driven either by the truck engine or by an auxiliary engine. This serves the same purpose as the chemical engine, with the added advantage of pumping continuous fire streams where water is available. With a suitable design such apparatus can be made of general utility to combat grass, grain and brush fires, as well as structure fires. Problems are involved in the selection of satisfactory chassis, pumps, power take-offs and equipment suitable for the district in which it operates. The solution of these problems requires the cooperation of the engineer, the fireman, and the underwriter.

Some other specific problems relating to rural fire-fighting equipment are:

1. Fire hose which resists the deterioration of time, rough usage and little care
2. Fire nozzles quickly adjustable to give the streams most efficient in the use of water
3. Water-supply systems suitable for fire protection as well as for domestic and irrigation purposes
4. Automatic fire suppression or fire alarm systems modified to meet rural conditions.

Forest fire fighting is in a class by itself in many respects. Nevertheless, some of the requirements are identical with rural fire fighting in general, especially in the border areas. Fire protection in the forests includes buildings and grass lands as well as timber. In many districts the state and federal forest services cooperate with counties and rural communities on fire protection, hence there is an interchange of equipment. Equipment problems include tank and equipment trucks, portable pumping units, tractors, trailmakers, and tools to expedite fire suppression and fire hazard reduction.

The development of equipment to meet the requirements of non-urban areas is a field worthy of the best efforts of the agricultural engineer. The particular portions of the field in which he can be of most value depends upon the training, ability, and interests of the individual. He may be of most service to agriculture by correlating and adapting to rural needs the information obtainable from many related fields.

Through the channels of commercial development or distribution of equipment, or through those of governmental work in research, resident teaching, and extension, agricultural engineers can make valuable contributions toward reducing fire loss in the open country.

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Anniversary

IN SOCIAL economy the recorded past is never a spent force. It remains ever potent to teach those who will do it the honor of study. Given an anniversary as a fulcrum upon which to pivot the long lever of time, it can give a tremendous boost to the progress of the future.

In this space-time world of ours main lines of agricultural engineering thought and action, plan and expectation, converge for the present upon the twenty-fifth anniversary meeting of the American Society of Agricultural Engineers at Iowa State College, June 22 to 25.

There and then will be assembled more than the personalities of agricultural engineering today. There will be the agricultural engineers of all time. Those of the past will be with us in the record of their works, in their surviving achievements and in the vital, aggressive, pioneering spirit they have handed down. Those of the future will be present in that same spirit, which will take hold of them as they become incarnate and "carry on."

It will be the anniversary of a meeting in the heyday of animal power in agriculture, when automobiles and internal combustion engines on farms were rare novelties; when, according to J. B. Davidson (page 182), the idea that engineering had anything to contribute to agriculture, was new. A meeting called principally by and for instructors in farm mechanics, out of a common want of subject matter information and teaching technique. A meeting attended by 17 young men who, after a great deal of deliberation and with some temerity, dared to see their work in a broad light, to form a professional organization and to dignify it with the name, "American Society of Agricultural Engineers."

In celebrating the birth of our profession we will inevitably add to the scientific understanding, artistic appreciation and inspirational energy to be taken back by each of us to our own work—work which makes up part of the foundation upon which future agricultural engineers will build.

Professor Davidson has said of that first meeting "Those present came feeling that they had a worthwhile job, but when they left the meeting they were inspired crusaders with a mission." History bids fair to repeat itself in this for those who attend the Twenty-Fifth Anniversary Meeting.

Opportunity

OPPORTUNITY was the birthright of the agricultural engineering profession. Until 1907 the possibility of applying science to contribute to the advancement of agriculture in an engineering way remained a free legacy, unclaimed by any profession. Then it was adopted as their opportunity by 17 young engineers who had been individually applying their technical knowledge in the interests of agriculture. They laid claim to it by establishing their professional identity and unity under the name of the American Society of Agricultural Engineers.

Our anniversary naturally suggests consideration of the extent to which we have as a profession lived up to this opportunity, and may continue to in the future. Three things stand out in the record of our profession's progress and service—research, education and professional unity.

Research we have employed as fully as funds have permitted, to produce basic data and to check our mental processes, designs, products, and proposals for the solution of specific agricultural problems. It has kept us headed in the right direction technically. Increasing support for the work is providing additional incentive to live up to our opportunity in this respect. Our only danger of leaving it is the temptation to rush to the aid of a distressed agriculture with new theories, methods, designs and equipment not fully checked by research. It is a temptation we must resist.

In education we have not only assured our own future by introducing professional courses in agricultural engineering into many land grant colleges; we have established ourselves in a larger way by translating the results of research into improved practices, materials and equipment, and making these readily available to farmers. We have also shown other branches of engineering and of agricultural science that we can cooperate effectively and aid them in some of their work. We have responded to the call whenever our special knowledge might be of value. Our educational work has been well directed; our opportunity calls for continued support and effort to increase its effectiveness.

Professional unity has given our work a mass and velocity which has enabled it to override many obstacles, to command attention and respect, to convert opposition into support, to challenge men to achievement and to reward their labors. It is a unity of purpose—to extend to agriculture the benefits of engineering. It has bound together individuals working in widely separated sections of this continent and the world, applying different specialized branches of engineering technique to the numerous and diverse problems of several different types and conditions of agriculture in different capacities and from different points of view. It has enabled them to work with some coordination and cooperation among themselves and with other groups. It has made possible group activities which are accessory to individual technical progress, as the holding of meetings and the accumulation of an agricultural engineering literature. It has promoted appreciation of the fact that engineering can benefit agriculture.

Since the charter members of A.S.A.E. established their professional unity their work has grown and more of the benefits of engineering have been extended to agriculture than in all the previous rise of engineering.

In 1907 seventeen agricultural engineers, all highly preoccupied with their individual problems, felt that professional unity would help them to apply engineering to agriculture. Is it not even more important today to a thousand agricultural engineers each working in a more specialized way on more detailed problems in a constantly broadening field?

Without professional unity we lose sight of our purpose, our identity; our techniques become irrelevant; we become useless, unattached, individualistic tinkerers; a lost hope of agriculture; black sheep among the other highly organized, forward looking, forward moving engineers.

With unity we can as a profession and as individuals live up to our opportunity.